Municipal and County Engineering

DESIGN, CONSTRUCTION, OPERATION AND MAINTENANCE OF ALL PUBLIC WORKS

Vol. LIX. NOVEMBER, 1920. No. 5.

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11-20

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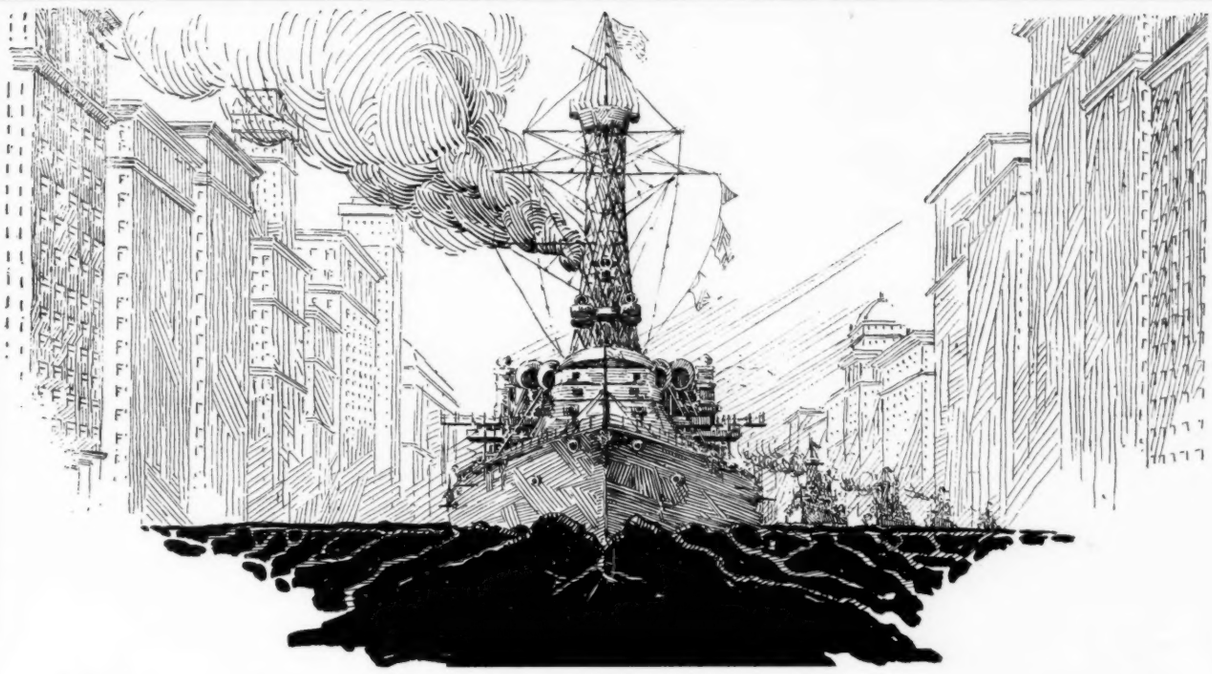

Floating battleships in asphalt

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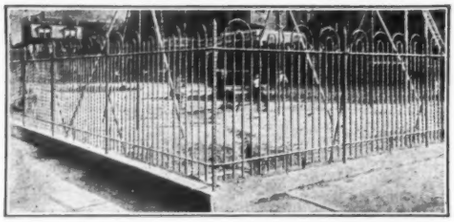

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demands that every institution be made a "thing of beauty forever." Your fellow-citizens and strangers will admire and appreciate your public buildings more if surrounded by a handsome iron fence.

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are protected and adorned by these beautiful fences, made after special designs by our own experts or your architects.

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TEXACO Engineer co-operating with Public Officials.

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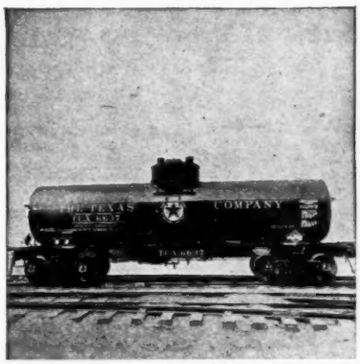
The expert engineers of THE TEXAS COMPANY help to draw up specifications, recommend specific types of construction, and give assistance on all practical and technical road matters.

Co-operation is the keynote of their work.

Our engineers are at the call of public bodies and officials, engineers and contractors. There is no expense or obligation incurred in having them co-operate with you.



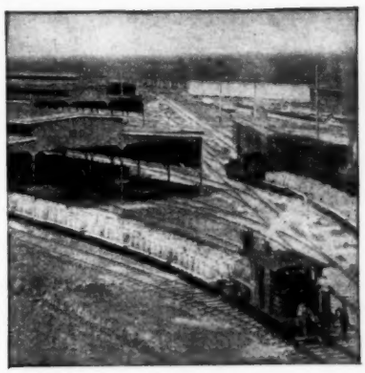
TEXAS COMPANY tank car bearing Asphalt on its way to build America's modern highways.

PROMPT SHIPMENTS

THE TEXAS COMPANY operates hundreds of its own tank cars, and in a thoroughly modern plant manufactures its own barrels and iron drums.

THE TEXAS COMPANY has several Asphalt refineries which are situated so as to promptly and conveniently serve every locality.

These and many other features make our Asphalt service what it is—unexcelled.



TEXACO Asphalt in barrels ready for shipment from refinery.

CONSTANT HELP

TEXACO service follows the highway problems of the public board, the engineer or the contractor from beginning to end—always lending a helping hand.

If you want to know the best way to unload a tank car, the various uses of Asphalt in highway work, and other helpful information, ask for our Service and literature.

(Specifications Furnished on Request)

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More of them are in use than all other makes because they have for years consistently maintained the highest reputation. Send for Catalog No. 26.

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No Bleeding REILLY'S IMPROVED PERMANENT CREOSOTE OIL *No Bulging*

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Plants: Indianapolis Minneapolis Mobile Seattle Norfolk

MOTOR TRUCKS

Motor Trucks as Operated in Municipal and County Service and in Highway Transportation

THIS PACKARD TRUCK CLIMBED THE BRIDGE GIRDER TO AVOID AN ACCIDENT. AFTER A WRECKING CREW HAD GIVEN UP THE JOB IT PULLED ITSELF BACK ON THE ROAD AND RESUMED ITS RUN UNDER ITS OWN POWER.

Printed as insert to MUNICIPAL AND COUNTY ENGINEERING, Chicago, Ill., November, 1920.

MOTOR TRUCK OPERATION AND ACCOUNTING LXIII

Important Transportation Conference Held at Akron

An important transportation conference was held at Akron, Ohio, recently, in response to a call by the Federal Highway Council. Committees were appointed to lay out and direct a movement to harmonize and co-ordinate all existing transportation agencies to the end that the public may have that form of service which is most efficient, economical and practical.

Highway officials from practically every section of the country were in attendance. The motor industry was well represented, and for the first time in history, railways—steam and electric—waterways and express companies took part in a good roads meeting, for such it was primarily.

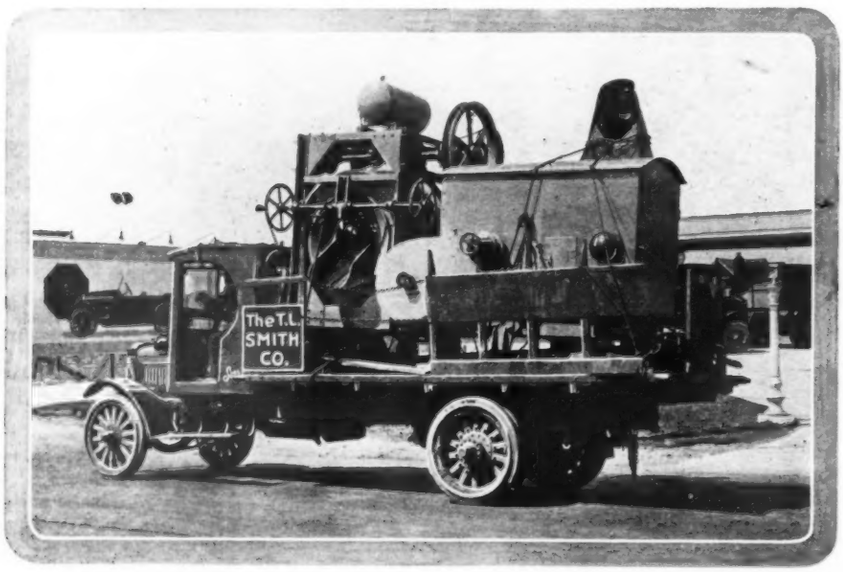
One of the serious phases of road development, that of subgrade and its relation to the road surface, came before the conference, under the leadership of C. M. Upham, State Highway Engineer of Delaware, and Vice-Chairman under General Coleman Dupont, Chairman of the Sub-grade Committee of the Federal Highway Council.

The work of this committee, it was pointed out, is in response to a demand that engineers find some way to overcome road failures which confront taxpayers at the present time, due to the attention which has been given to the surface construction at the expense of the foundation on which the surface rests. The committee will seek to determine definitely how sub-soils shall be treated in order to prevent damage to the costly road surface. In the hope of accomplishing this purpose, field tests will be made to determine the bearing power of various kinds of soil, studies will be conducted in drainage, and a study also will be made to ascertain by what chemical method the bearing value of the soil may be increased.

Among the engineers of note on this committee are A. T. Goldbeck and Ira B. Mullis, Bureau of Public Roads, Washington, D. C.; Paul D. Sargent, President American Assocoiation of State Highway Officials; Col. H. W. Alden, representing Society of Automotive Engineers; Professor D. A. Abrams, Chair of Engineering, Lewis Institute, Chicago; Prof. F. H. Eno, Research Engineer, Ohio Good Roads Federation and Chair of Engineering, Ohio State University; H. J. Hughes, Dean of Harvard Engineering School, Harvard University; M. L. Enger, Professor of Mechanics and Hydraulics, University of Illinois; Prof. A. H. Blanchard, Chair of Highway Engineering and Highway Transport, University of Michigan; Prof. C. J. Tilden, Chair of Engineering, Yale University; Dr. Joseph H. Pratt, Professor of Geology, University of North Carolina; C. C. Wiley, Assistant Professor Highway Engineering, University of Illinois; A. N. Johnson, Dean Civil Engineering, Maryland State University; Dr. G. E. Condra, Director, Conservation and Soil Survey Department, University of Nebraska; Frank Conley, Montana State Highway Commissioner; Ira R. Browning, Utah State Highway Engineer; W. S. Keller, Alabama State Highway Engineer; M. W. Watson, Kansas State Highway Engineer; H. E. Hilts, Principal Assistant Engineer, Pennsylvania State Highway Department; D. S. Humphrey, Ohio State Highway Advisory Board; L. A. Nares, Fresno, Cal.; W. P. Blair, of Cleveland, Ohio, and H. G. Shirley, former State Highway Engineer of Maryland, and Secretary of the Federal Highway Council.

Co-operating with the above group are leading executives in the motor industry. Their definite and express purpose is to open the way for the construction of roads that will meet not only present, but future traffic on the highway, and permit the motor truck to assume its inevitable position as a real factor in transportation.

The relations of the highways to railroads, waterways



THIS 14-FT. SMITH MIXER, EQUIPPED WITH A 10-H.P. GASOLINE ENGINE, STEEL HOUSING AND POWER LOADER, WAS HAULED ON A 3½-TON SERVICE MOTOR TRUCK FROM CHICAGO TO BELOIT, WIS., A DISTANCE OF OVER 90 MILES, IN 7 HOURS, BY THE LEONARD CONSTRUCTION CO., OF CHICAGO, DURING ONE OF THE RECENT STEAM RAILWAY TIE-UPS.

DUPLEX TRUCKS
BUILT FOR BUSINESS

Is Transportation a Problem In *Your* Business, *Too?*

If It Is, Read This. It is Published in the Desire to be of Help in Meeting a Common Problem

HAVE you ever thought as seriously as you should of the motor truck in connection with your transportation problem?

Not necessarily of the truck *instead* of the railroads, but of the truck *in addition* to the railroads.

With the average freight car travelling only *25 miles per day* business is slowed up in spite of itself.

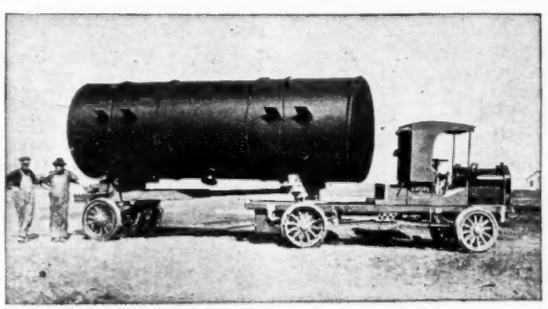
Here is a big field—big with real and potential aid in helping you to do business *without hindrance* and on terms of practical economy.

Now, perhaps, you say that this won't work out. But wait. *It is working out right now.*

Perhaps your observation or your experience has been with the *wrong kind* of truck. Nine times out of ten, so-called trucking disappointments have been remedied by *using the right kind of truck.*

Maybe you want facts. If you do—write us and we will give you real facts about Duplex Trucks—the famous Duplex 4-Wheel Drive, known everywhere as "America's Leading Heavy Duty Truck"; and also some real facts about the wonderful Duplex Limited—the High Speed, Pneumatic Tired Truck that can really haul 3000 to 5000 pounds at high speed over roads as they are.

Read the following and see if it doesn't seem reasonable to believe that these Duplex Trucks are worth knowing about. Write—and do it today.



The Duplex 4-Wheel Drive 3½-Tons Capacity

A Wonderful Truck for Economical Heavy Hauling

IF you have a heavy hauling problem and do not already know the Duplex 4-Wheel Drive, talk to the Duplex dealer and let him give you the facts at first hand.

The Duplex Truck Company is the originator of the 4-Wheel Drive principle and today its most successful exponent.

There is pull and power in every wheel—and the Duplex 4-Wheel Drive keeps going under conditions that are simply impossible for any rear wheel drive trucks.

The Duplex 4-Wheel Drive is setting new records of truck efficiency for Lumber and Logging Companies; Road Builders; Oil Companies; Coal Companies; Mining Companies; Grocery Companies; Trucking Contractors—in fact in all lines where there are heavy loads to be hauled.

The point is the Duplex 4-Wheel Drive is daily proving to be a very *economical truck* for hundreds of owners who used to say it was too big for their needs.

Write us for folders about the Duplex 4-Wheel Drive. Talk to the Duplex dealer near you. He will give you only facts

DUPLEX BUILT FOR BUSINESS

The Duplex Limited

High Speed; Full Electrical Equipment; Pneumatic Tires; Capacity 3000 to 5000 pounds at 5 to 25 Miles Per Hour on High

HERE is a photograph of the Duplex Limited that carried 3060 pounds from Los Angeles to El Centro via San Diego at an *average speed of 34 miles per hour.* No stops during the run. No relief driver. Ran through rain from Santa Ana to Oceanside. *Speed limit observed in all towns in transit.*

Another Duplex running from New Orleans to Baton Rouge with 3750 pounds, 124.6 miles in 6 hours and 55 minutes running time.

Another running from Waterbury, Conn., to Boston—175 miles in 5 hours and 27 minutes.

It fits in exactly with the universal effort to *stabilize schedules;* to obtain *quicker delivery;* and to secure *greater economy.*

4 Cylinder, enclosed type motor—water cooled—cast enbloc—Bore 4-inch, Stroke 5½-inch. 3 Point Suspension, Pneumatic Cord Tires, 145-inch Wheelbase. Equipped with Windshield, Electric Lighting and Starting, Ammeter, Boyce Motormeter, Speedometer, Electric Horn, Tools, Jack, Rim Wrench, Front Fenders, Alemite High Pressure Lubricating System.

Just the right truck for Delivery, for Inter City Express and for all speed hauls. Get the facts about it

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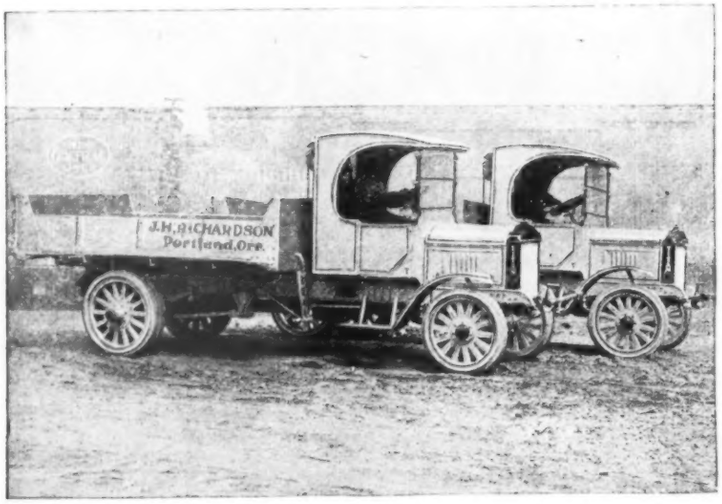
Lansing · Michigan

One of the Oldest and Most Successful Truck Companies in America



TWO 3½-TON TITAN TRUCKS EQUIPPED WITH COMBINATION ASPHALT BODIES FOR ROAD WORK.

and other forms of transportation to the end that such carrier agencies may be properly co-ordinated in public service—this problem is in charge of a committee headed by W. J. L. Banham, of New York, member of the Executive Committee of the National Industrial Traffic League.

While supporting the movement to make a larger use of the public highway as a freight and express carrier, Colonel Charles Hine, of New York, an expert on motor terminals, challenged any member of the conference to show any such record in empire building as the American railroads had achieved in the past ninety years.

Throughout the entire session lasting two days, due credit and appreciation was given the railroads for the work performed; at the same time expressing a determination to make a larger and more extended use of the motor vehicle through the construction of more lasting types of road.

Mr. M. S. Connors, General Manager of the Hocking Valley Railway Company, and the representative on the committees of the American Railroad Association, showed a keen interest in the different problems before the committees.

The American Electric Railway Association was represented in the committes by Mr. G. T. Seely, Vice-President and General Manager of the Pennsylvania-Ohio Electric Co., who took an active part in the meetings.

F. S. Holbrook, Vice-President of the American Railway Express, pledged the co-operation of the interests which he represented, in the movement, to add the public highway to the Nation's transportation system.

The Federal Government was represented by Dr. R. S. MacElwee, Director of Foreign and Domestic Commerce, Washington, D. C., Major J. M. Ritchie, Motor Transport Division, Transportation Service, Quartermaster's Corps, Washington, D. C., and L. L. Robinson, Council of National Defense, Washington, D. C.

The Agricultural interests were ably represented by L. J. Taber, Master of the Ohio State Grange, who outlined the transportation needs of the farmer. Mr. Taber is also a member of the Executive Committee of the Council.

Civic organizations were represented by Messrs. Donald O. Moore, John McNally and P. W. Moore, General Traffic Managers of the Pittsburgh Chamber of Commerce, Detroit Board of Trade and Long Island City Chamber of Commerce. Among other prominent traffic men were R. L. French and George F. Hichborn, General Traffic Managers of the Columbia Graphophone Co., and the U. S. Rubber Co.

Others of prominence attending were Prof. A. H. Blanchard, Chair of Highway Engineering and Highway Transport of the University of Michigan; W. F. Knowles, of New Jersey State Agricultural College; John T. Stockton, President Joseph Stockton Transfer Co., Chicago; D. S. Ludlum, President of the Autocar Co.; and W. A. Collic, Superintendent Freight Transportation the New York, Chicago & St. Louis Railroad Co.

The fundamental manner in which Virginia has gone about the work of bringing her roads up to modern requirements occupied the attention of conference members on the second day. "Virginia's New Hour," a state photo-play made under the direction of the Council's Educational Bureau, and in which more than two thousand Virginians appear on the screen, was shown at one of the Akron theaters, followed by a short review of the Federal Highway Council's method of aiding State Highway organizations in the conduct of state campaigns to provide sufficient capital for highway construction upon a large scale.

An educational committee under the chairmanship of W. E. Blodgett, of Philadelphia, was formed to co-operate with the Educational Bureau in furthering the efforts of the Council in practical and intelligent highway development.

Meetings of a similar character will be held at other centers where the production of highway rolling stock is a leading industry.

Duplex Limited Makes Record Run

Mr. H. G. Pendell recently lowered the motor truck running time between Los Angeles and Santa Barbara. He made the run in 3 hours and 9 minutes. The story of his performance is interesting as an indication of the rapid transit possibilities of the truck and the highway. This record run represents an average of 37½ miles per hour running time over 118 miles of every kind of road. The average, including all stops, was almost 20 miles per hour.

The Duplex Limited Truck, loaded with 1,741 copies of a Sunday newspaper left Los Angeles at 2:30 o'clock

MEAD-MORRISON SERVICE

LIFTS THE LOAD OF INDUSTRY

SERVICE of a worth-while nature is what Mead-Morrison offer the purchaser of their equipment. A trained staff of engineers gives its attention entirely to obtaining maximum usefulness from equipment in the hands of clients.

Many and varied are the uses of the Mead-Morrison Vertical Capstan Winch.

The accompanying illustrations show this efficient machine hoisting the aeroplane of that gallant and famous daredevil, Lt. Locklear, to a roof previous to a hair-raising "stunt" for the movies.

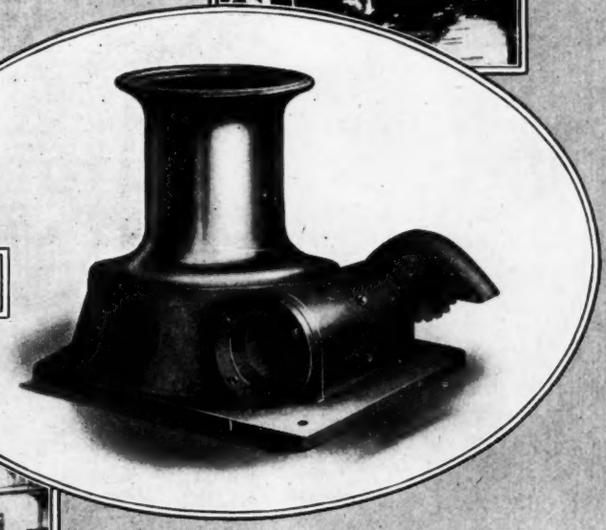
Its use solved a problem that otherwise would have involved the aid of a great deal of man power—and an unusual waste of time.

In the remarkable adaptability of Mead-Morrison Equipment lies a great deal of its value and power.

Other Mead-Morrison Equipment includes Steam and Electric Hoists, Grab Buckets, Conveyors, Car Pullers and the Horizontal Drum Winch.

DISTRIBUTORS

Auto Truck Equipment Co.	Pittsburgh, Pa.
Edward R. Bacon Company	San Francisco, Cal.
Hummel Mfg. Co.	St. Louis, Mo.
Interboro Hoist & Body Co.	Brooklyn, N. Y.
Kunkel Wagon Co.	Baltimore, Md.
Mansfield Steel Corp.	Detroit, Mich.
Motor Truck Equipment Co.	Philadelphia, Pa.
William Ogden	Indianapolis, Ind.
Springfield Commercial Body Co.	Springfield, Mass.
Springfield Commercial Body Co.	Cambridge, Mass.
The Truck Engineering Co.	Cleveland, Ohio.
Wisconsin Motor Parts Co.	Chicago, Ill.



REGISTERED IN UNITED STATES PATENT OFFICE
M M & M

ENGINEERS & CONTRACTORS

MEAD-MORRISON MANUFACTURING COMPANY

1126 Prescott Street, EAST BOSTON, MASS.

COAL HANDLING & HOISTING MACHINERY

in the morning. The net weight of each newspaper was 1¼ lbs., the papers being wrapped in bundles of from 6 to 50 copies, for distribution to rural carriers. Stops were made at Hollywood, Santa Susana, Moorpark, Somis, Oxnard, El Rio, Ventura, Rincon, Summerland and Montecito at which places papers were discharged.

From Ventura to Summerland a dense fog was encountered which made the trip extremely hazardous. Six cars were passed wrecked along the road between Somis and Summerland. Between Ventura and Rincon the road follows the breaker line of the Pacific Ocean, going so far out at times that bridges have been built over the small bays and inlets.

At no time on the entire trip, except just before the finish, was the Limited allowed to use its full power on the level roads, being held to a speed of 40 miles per hour. Merely as a test of ability and reserve power, Pendell maintained a speed of 50 miles an hour for a short stretch when the fog lifted a little.

The Duplex arrived in Santa Barbara at 6:28 o'clock, just 3 hours and 58 minutes from the time the truck left the corner of First and Broadway in Los Angeles. A total of 49 minutes was lost for paper stops. After discharging the last of the papers it was found that the Duplex had used a little over 8 gals. of gasoline, making an average of 13 and a fraction miles to the gallon.

Duplex Limited Makes 24 Hour Continuous Run on Indianapolis Speedway

In a most convincing manner the Duplex Truck Co., Lansing, Mich., recently demonstrated to truck users, manufacturers and dealers alike the fact that the high speed pneumatic tired truck can claim a big place in modern transportation.

Stock Model "A" Duplex Limited No. 5191, Motor No. 41827 loaded with gasoline, oil and ballast weighing in at 8,300 lbs. exclusive of drivers, was placed on the Indianapolis Motor Speedway and beginning at 1:57 P. M. September 30th was operated until 1:57 P. M. October 1st without a stop of any kind being made.

For 24 hours continuously this Duplex Limited circled the speedway at an average speed of over 38 miles per hour and covered a total distance of 935 miles, and not a stop of any description was made during all this time.

Fuel was supplied from four drums of gasoline mounted in the body which were connected right to the carburetor. The regular gas tank was used for oil, the lead from this tank being tapped into the engine filler. The original set of tires made the entire trip without difficulty. The drivers were given food on the run to do away with the human necessity for a stop.

No attempt was made to hang up a speed record but rather to demonstrate the all around type of service that a truck of the character of the Duplex Limited could be expected to render in everyday work.

The chronometer was used for timing, a record being made at each lap. The consistency of the truck's speed in this run is very evident from the fact that no lap was run at a rate slower than 35 miles per hour or faster than 42 miles per hour.

And to demonstrate that the Limited still had a reserve of speed, at the conclusion of the run and without stopping, the truck was shot around the speedway for one lap at the rate of 44.5 miles per hour.

The conditions under which the Duplex Limited was run were as near actual service and road conditions as possible. The truck was a regular stock model, carrying a rated load and the surface of the speedway was rough like the majority of roads over which trucks are operated, including a temporary 14 ft. wooden bridge.

Needless to say the results were gratifying to everyone and they will have a far reaching effect on the future design and adoption of trucks for certain types of work.

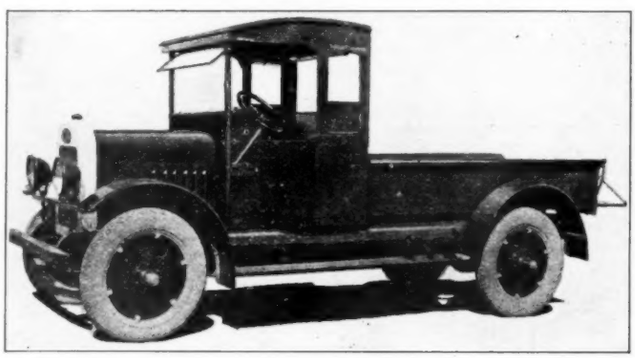
Gramm-Bernstein Adds a New Speed Truck

The Gramm-Bernstein Motor Truck Co., Lima, Ohio, announces a new speed truck for loads up to 1 ton.

Simplicity and accessibility of design, which should contribute greatly to easy and prompt adjustment, characterize this truck. The manufacturers claim many points of superiority over the conventional type of speed truck, chief of which is their contention that they have built along light-truck, rather than passenger-car lines.

An all copper and brass radiator, protected by a staunch cast semi-steel shell mounted on the frame with springs, is used instead of the conventional terne plate or galvanized radiator, rigidly mounted.

The power plant is a 3½ x 5 in. high speed engine with removable head, hot spot manifold and stove on exhaust pipe for triple heating fuel and the manufacturers claim unusual efficiency and economy, having obtained an average of over 12½ miles to the gallon of gasoline under full load. One interesting feature of the engine is a con-



THE NEW MODEL 10 GRAMM-BERNSTEIN SPEED TRUCK.

struction which permits the valve tappet guides and tappets to be easily removed en bloc. The engine suspension is semi-flexible, three point to main frame, with large trunioned support at front end, as against the sub frame construction, which is still adhered to by some manufacturers.

A 10 in. ten spline shaft dry plate clutch is used, enclosed in unit with the engine. Transmission is sliding gear type, three speeds forward and reverse, with nickel steel shafts and ample gear faces, shafts being mounted on double row annular ball bearings with additional roller bearings at the junction of the two sections of high speed shaft.

The propeller shaft is tubular, and the usual Gramm-Bernstein flexible oilless disc joints are used at both ends of the shaft.

The rear axle is three-fourths floating, bevel type, gears being of helical spiral design, accurately cut and mounted on large annular bearings, the manufacturers claiming absolute quiet as well as longevity in service.

IMPORTANT ANNOUNCEMENT OF

MUNICIPAL AND COUNTY ENGINEERING TO ADVERTISERS AND ADVERTISING AGENCIES
with Respect to Change of Size for 1921

Beginning with the January, 1921, edition the size of MUNICIPAL AND COUNTY ENGINEERING will be changed by returning to the size continuously used by this publication from 1890 to 1915 (25 years), namely, a 7 x 10-in. page with a page *type-size of* 5½ x 8 *ins.*

This change was decided upon months ago and would have been made effective at that time but for the fact that a large number of subscribers bind their copies of this magazine each year and the publishers did not wish to cause inconvenience or annoyance to these valued readers by changing the size of the paper during the year.

The new size, always very popular when employed before, will be equally popular in future and many readers have expressed a preference for the "magazine size" which is being used by other monthly magazines in the municipal field at this time. The exchange of advertising electrotypes in the municipal field will be facilitated, in the majority of cases, by this change.

Aside from reader preference, moreover, considerations of economy and efficiency clearly call for the change. All are familiar with the present cost of paper stock. The price is so high as to make efficient use of paper imperative. The reduction in size will, of course, save paper on each copy and the total number of copies printed and distributed will be correspondingly increased, while the total consumption of paper will not be decreased. Obviously it is in the interest of all parties to extend the circulation of a magazine and thereby increase its usefulness.

The circulation of this magazine, therefore, will be very substantially and legitimately increased beginning with the January, 1921, issue. Full particulars on that point will be given to advertisers and agencies in the regular course of business, the primary object of this announcement being to call attention to the impending change of size and briefly to suggest the reasons for making the change.

Advertising production departments should note the new full page size and provide half-tones and electrotypes for use on a 5½ x 8-in. (type-size) page for the January, 1921, and subsequent issues. The publishers will give individual attention to all fractional page accounts, and to all standing advertisements without inconveniencing the advertiser.

MUNICIPAL AND COUNTY ENGINEERING

538 S. Clark St. Chicago, Ill.

The housing is pressed steel with heavy drawn steel tubes and is further strengthened by a well anchored truss rod underneath. The complete differential and carrier is easily removable as a unit after drawing the drive bars by simply unbolting from the housing. Drive bars are ample size, of chrome nickel steel, the wheel bearings being extra large double row annular.

One specially interesting feature of the new Gramm-Bernstein is the aeroplane type laminated wood disc wheels, 9-ply front and 11-ply rear, which the manufacturers claim not only add to the appearance of the truck but also to the life of the tires, besides obviating expense incident to loosening spokes in artillery type wheels. It is claimed that sets of these wheels which have been run over 40,000 miles have shown no signs of warp or wear.

Gramm-Bernstein calls particular attention to the springs and frame, the former being of extra length and quality and the latter being a straight section pressed steel channel construction. Following their usual practice, the front end spring hanger is a separate casting, this also providing for lamp and fender supports and anchorage for the bumper, which is channel steel. It is claimed for the frame and spring construction that the truck not only rides easier than most passenger cars but that it also holds the road much better than is possible with the usual light frame.

The service brake is 16 x 2 in. on rear wheels with a simple and positive cable and pulley equalizer which is really ingenious. The emergency brake is a contracting band on the propeller shaft.

Ignition is Connecticut, with automatic circuit breaker to prevent battery exhaustion; water circulation is thermo-syphon, the large radiator insuring ample cooling; lubrication, combination force feed and splash; gasoline supply, 16½ gal. tank mounted in the dash, insuring strong gravity feed.

Springs are designed to carry flat under rated load and are fitted in each hanger with graphite impregnated oilless bronze bushings, requiring no further lubrication.

The chassis with 35 x 5-in. tires front and rear, electric lights and starter, speedometer, compression whistle, front and rear fenders with running boards and dust shields, bumper, jack, pump and full set of tools, front and rear license brackets, spare rim, etc., will be sold at $1,495 and the truck is listed in 16 combinations of bodies and equipment, ranging up to $1,780. Painting is included in price, Military green body, cab and hood, Carmola red chassis and wheels, black fenders and lamps. The wheel base is 128 ins., loading space back of seat 8 ft., bed of bodies 34¾ ins. from ground when empty, turning radius 20 ft., road clearance 10⅝ ins., weight of chassis 2,370 lbs., body allowance 750 lbs. Truck has speed up to 45 miles per hour.

Body combinations include express flareboard, standing top, grocers' double-deck basket rack, stock rack, tight grain box, passenger seats, screen side standing top, solid panel, slatted stake, chain stake, bus, etc. Full storm curtains are provided where necessary, with door curtains opening with doors, which are furnished in all seat and cab combinations.

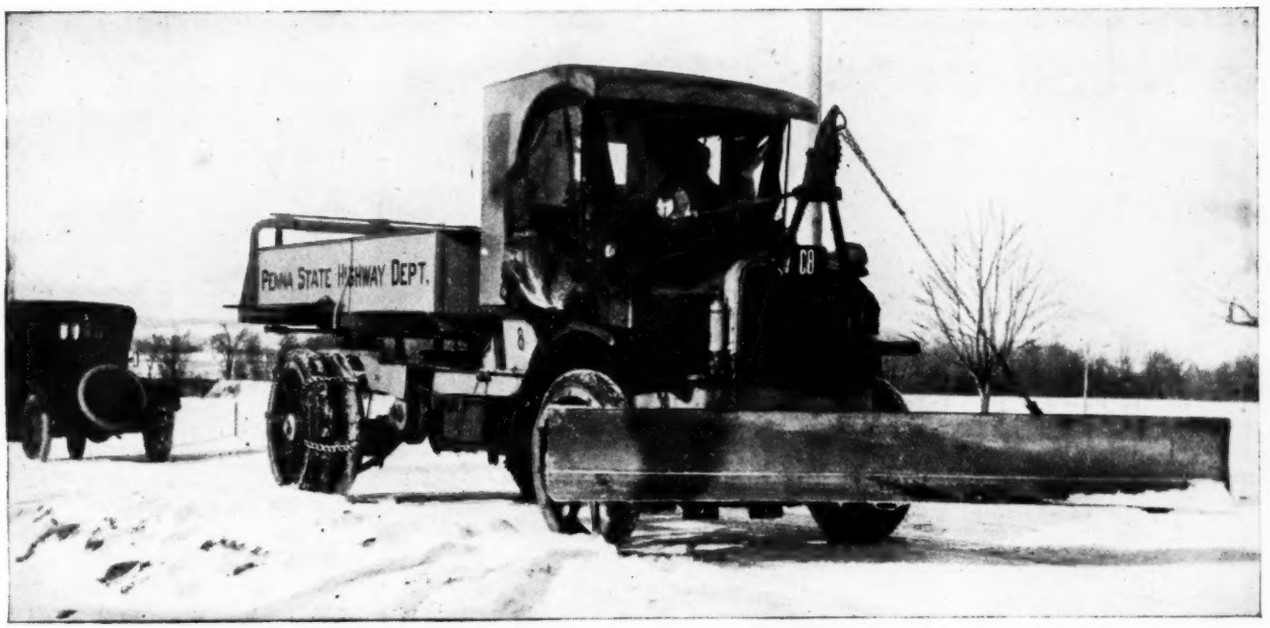
Minute care and attention to detail is exhibited throughout the design of chassis and bodies.

First samples are now undergoing grilling tests under load over Ohio and Pennsylvania hills, covering 20,000 miles, and immediately upon completion of tests a limited number of sample trucks for dealers will be built, regular production beginning about Jan. 1, 1921.

New Cable Pulling Apparatus

The Mead-Morrison Mfg. Co. has recently perfected a new cable pulling apparatus which is a decided improvement over anything previously in use.

CHAMPION SNOW PLOW ATTACHED TO A WHITE TRUCK, AS OPERATED BY THE CITY OF AKRON, OHIO.



Champion Snow Plow attached to a White Truck. Used by the Pennsylvania State Highway Department.

"Business as Usual"—all winter long

The simple solution of the snow removal problem is an adequate equipment of Champion Snow Plows.

Traffic tie-ups and suspended business, due to excessive snow falls, are a thing of the past in the county, state or city that has standardized on Champions. Costly and unsatisfactory hand labor is eliminated.

Champion Snow Plows are easily attached to any standard motor truck and are quickly detachable when truck is to be used for other purposes. Write or wire for Bulletin K. D. T. containing full particulars and many photographs.

Branch Offices:
Boston, Mass.
New York, N. Y.
Philadelphia, Pa.
Pittsburgh, Pa.
Chicago, Ill.
Portland, Oregon
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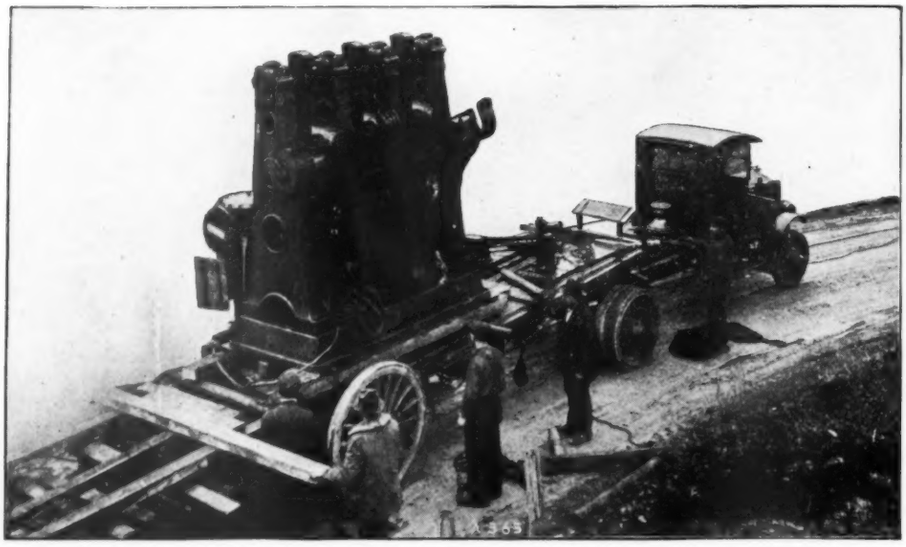
Fort Wayne, Ind.
Denver, Colo.
Billings, Mont.
Boise, Idaho

General Sales Offices:
837 Bulletin Building, PHILADELPHIA, PA.

The GOOD ROADS Machinery Co., Inc.

"Everything for the Roadmaker"



LETTING THE TRUCK ENGINE DO THE WORK—A MEAD-MORRISON TRUCK WINCH IN OPERATION.

The equipment takes the form of an underslung winch, attachable to the rear underside of the frame of a motor truck, therefore occupying none of the room on the body.

It enables the user to employ a smaller truck capable of higher speed and with a short turning radius. Its position at the rear of the truck makes it possible to back the truck up to the manhole—saving room in the street.

The winch has a pull of 5,000 lbs. and the drum will hold 425 ft. of seven-sixteenths inch wire rope.

The machine is used in connection with the power transmission of the truck to which it is attached and its speed is governed by the speed of the truck.

The apparatus is easily operated by one man. Its method of pulling is so sensitive that the operator can tell immediately by the "feel" whether or not any obstacles are being met. This prevents the possibility of damage done to the cable by sharp objects or obstacles in the duct.

Many telephone companies and other industrial concerns having cable to lay have recognized the value of this efficient machine. Its money saving and time saving value is obvious.

Truck Rescues Itself

A recent exploit of a motor truck in rescuing itself after an accident on a bridge outside of Los Angeles will give to many people a new idea of the stability and trustworthiness of these vehicles.

The truck, which was a Packard, got into trouble through the violation of the headlight law by the driver of a passenger car. It was loaded with eight tons of cement and had another eight tons on a trailer. Just as the driver started to cross a bridge the passenger car, in trying to pass another one, pulled out sharply to the left, with headlights blazing and it both blinded the driver of the truck and also forced him over to one side.

The front right hub of the truck he was driving caught a fence post and the wheel, after climbing a 10-in. concrete curb around the base of the steel bridge girder, climbed over the end of the girder, ran along the top for several feet, and then with front wheel riding the girder, the truck moved down the bridge for more than its own length. When the truck stopped, the rear wheels were on the bridge and one front wheel and the radiator were about 5 ft. higher and hanging over the edge of the girder.

After a wrecking crew had given up the job of putting

A MEAD-MORRISON UNDERSLUNG FRICTION DRUM WINCH IN OPERATION AS A CABLE PULLER.

the truck back on the road, the driver decided to see what he could do with the truck itself. So the engine was started and the truck backed up, sliding the front axle along the top of the girder in spite of the heavy rivet heads that impeded its progress. The truck was finally pulled clear across the girder and the whole front end dropped about 3 ft. to the bridge floor. In spite of this, inspection showed that the only damage from the accident had been a slight bending of the front axle, the dislocation of some of the leaves of the front spring, and the loosening of the steering rod. Within 30 minutes the truck was on its way again under its own power.

Motor Busses Long in Service

Nineteen years' hard service and still running continuously, is the record of a motor which has traveled 324,000 miles to date. Higgins Tours, of Chicago and New Orleans, who owns this bus, has four others between 14 and 18 years old, all of which are mounted on Mack 2½-ton chassis. In winter, they are operated in New Orleans as sightseers for tourists, and in summer they are transferred to Chicago, where they are used in general passenger transportation. Mr. L. G. Higgins, proprietor of the company, says, "They have given excellent service during all the time I have used them and in no instance have they ever missed a single trip."

Mr. Dan Tankersley, Sapulpa, Okla., wired **"Heltzel 'Lightning' Loader Skips giving perfect satisfaction."**

The ever increasing number of satisfied buyers prove the **"Lightning"** Loader Skip is a necessary piece of equipment for unloading open cars.

$60.00, 1 cubic yard size
70.00, 1½ cubic yard size

Write for literature TODAY.

The Heltzel Steel Form & Iron Co.
WARREN, OHIO.

ACME TRUCKS

Serving Municipalities

Efficient transportation is vital to the Village of Palmyra—as it is to every progressive municipality. The many constructive duties of civil government require a dependable and certain haulage system. Palmyra has found this dependability in a 2-ton Acme truck. Mr. S. M. Young, Village Clerk, has this to say:

"Last season the Village spent about $3,000.00 for teams, with not very pleasant results. This year, with the Acme, when we have spent this amount of money, we will have from two to three times the amount of work done and we will have about $2,000.00 paid on the truck. Our street superintendent has not so far employed a single team and the truck has handled the full job."

Acme Trucks fulfill the expectations of municipal engineers wherever they are used. They perform steadily, day after day, with a certainty that is born of "proved units—Acme constructed." That Acme is particularly fitted for the strenuous duties of contracting and engineering work is proved by the fact that over 21 per cent. of all Acmes made go into this service.

We invite inquiries for further information. We have some very interesting data on Acme performance in this field.

On the radiator of every Acme is this Seal of Dependable Performance

ACME THE TRUCK OF PROVED UNITS

Trade Mark Registered U. S. and other countrie

Made in 1, 1½, 2, 3½ and 5 ton Models.

Acme Motor Truck Company
319 Mitchell St., Cadillac, Mich.

MACRAE'S BLUE BOOK

AMERICA'S GREATEST BUYING GUIDE

Make this Book Your Buying Guide

It Tells You

—Where to get the material you need
—Where you can get best prices
—Names and addresses of manufacturers of every product
—All the miscellaneous data you need about the material you use

and a whole wealth of valuable information to help you in your buying. The old adage "Goods wisely bought are already half sold" is just as applicable to you whether you are wholesaler, retailer or manufacturer. With MacRae's Blue Book you have the country's markets before you. You know who manufactures the product you need—you know where your nearest sources of supplies are—you have the names of every competitive firm on every product to enable you to "pick and choose" wisely. You are not dependent on your present sources of supplies—not in trouble if your present sources fail you—you have easy access to the country's whole reservoir.

SHOWS YOUR BEST MARKETS INSTANTLY

and of no small import is the speed and accuracy with which MacRae's points out your best market. In this one volume of over 2,000 pages you have as much information as you could store in 160 feet of book cases, of catalogs, folders, etc. That would mean endless searching for any data you might want, but with MacRae's system of indexing and cross indexing it is instantly available. All you need to know is the name of the product and the country's market is open before you, or if you know only a trade name it is only a moment to find out all about the product and its manufacturer.

A Necessity to Every Purchasing Agent

Every purchasing agent knows what a hopeless task it is, trying to collect dependable, comprehensive information by merely using catalogs or some other such methods. Neither has he the time to waste going over masses of booklets, folders, etc., nor can he afford to run a chance of over-looking what might prove his best possible buy. With him MacRae's complete information is indispensable. It tells him which of the 35,000 United States manufacturers can best supply his needs, and tell him instantly.

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The time and money saved on purchases quickly pays the cost of MacRae's Blue Book. But you need not pay one penny until you have the book on your desk—have noted carefully the storehouse of information it contains—have satisfied yourself through ten days' actual use in your own work, that it is worth ten dollars to you. Delay is expensive in these days of scarce materials and changing prices—mail the coupon below for your copy—NOW.

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Gentlemen: Send us ..... copies of the 1920 MacRae's Blue Book. If we are not entirely satisfied with the books we will return them in ten days at your expense and you are to make no charge against us. If we decide to keep the books, you can bill us $10.00 per copy—the price of the book.
Company .....
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Free from steel and foreign scrap. High rust resistance; fibrous structure which prevents crystallization; strong, safe welds and excellent threading qualities, insuring permanently tight joints. Ask for particulars.

A.M. BYERS COMPANY
·PITTSBURGH·PA·

EDITORIALS

ON PAPER OR ON THE GROUND?

An unprecedented mileage of hard roads will be built in this country during 1921, but whether the record will be made on the ground or only on paper remains to be seen. As we are interested, in common with all others presumably, in seeing the roads actually constructed, let us face squarely one cause which again bids fair to contribute to a paper record only. We refer to the open-top car problem, and it is a problem of prime importance.

First of all let us stop weeping with the railways over their real and fancied misfortunes. They seem to have achieved their ends with respect to rates. Let us admire their political cleverness but let us demand service. From what we have seen of railway operation and from what we have heard of the amenities of the construction camp we will hazard the opinion that a judicious application of construction camp profanity to railway operatives will amazingly speed up the movement of open-top cars. Railway men from president down to back flagmen should be made to realize keenly that it is time for them to stop blubbering. It is up to them to deliver now. That rail-transportation has improved recently is gratefully acknowledged and should be accepted as evidence that greater improvement is possible.

But while reasoning with the railway interests in the manner described let us also better order affairs in the highway field. Road construction contracts should be awarded as soon as possible and successful contractors should, so far as possible, transport road building materials during the winter months and store them where they will be much wanted when construction opens up in the spring. This will relieve transportation congestion. By using open-top equipment for construction materials during the season when harvest, ore and coal movements are not at their maximum the general transportation situation will be benefitted greatly.

Contractors who have material available for use next spring as soon as weather conditions permit construction work will be spared the expense incident to the usual rail congestion and car shortage. It is thought that the resulting economies in highway production will much more than offset the interest on the investment in materials. In road building, as in any kind of manufacturing, it pays to have materials on hand when wanted in the production schedule. Certainly it is very expensive to shut down a road building plant frequently while waiting for materials.

In some states money may be advanced to the contractor for material on hand; elsewhere material on hand will facilitate securing bank credit.

It is hoped that state highway departments and road contractors will do all possible this winter in providing construction materials for early use next spring. Much can be accomplished in a spirit of forehanded cooperation.

A PLEASANT INCIDENT

Very often we have endeavored to convince an engineer that his work is of interest to the public and to his profession. While some engineers appreciate this truth, others, perhaps the majority, do not. There is no question of sincerity involved, of course, as it is the honest belief of the average engineer that his work is devoid of news value. We do not concur in this belief for its fallacy has been demonstrated many times. A recent incident serves to illustrate the point we have attempted to establish.

Not long ago we received an unsolicited contribution from a county engineer with whom we had not been in correspondence at all. In submitting his brief article he stated that he was doing so in line with a suggestion he had received from an acquaintance. The article was offered as a contribution without thought of direct compensation and with the statement that if considered unavailable it need not be returned. Two pictures accompanied the manuscript.

This contribution, so generously and so modestly submitted, was considered worthy of publication in this journal, and it appeared in a recent number. As soon as that issue was out a telegram was received from a very prominent national, weekly magazine, asking permission to reprint the article and requesting the use of the original photographs. Of course, it was a distinct pleasure to grant this permission and to forward the photographs. As soon thereafter as possible quotations from the article, attractively illustrated, appeared in the national magazine and the modest circulation given by this journal to the original article was increased by hundreds of thousands by the publication of the quotations. Full credit was given the author by the popular magazine. His story and the pictures were considered of sufficient popular interest to make the top of a right-hand page near the front of the widely-read weekly.

While such incidents have occurred before we derived very great pleasure from this case because of the modest manner in which the original article was brought to our attention. We hope this brief review of the circumstances will persuade other engineers to write of their work, which is probably of more interest to the public than they realize.

THE CHICAGO DRAINAGE CANAL: TODAY AND TOMORROW

By Francis C. Shenehon, Mem. Am. Soc. C. E., Mem. Am. Inst. of Consulting Engineers, Consulting Hydraulic Engineer, 628 Metropolitan Bank Bldg., Minneapolis, Minn.

The recent decision of Judge Landis of the Federal Court making permanent the injunction limiting Chicago from taking more water from Lake Michigan than is fixed in the permit of the Secretary of War marks the end of a chapter in the most celebrated case involving hydraulic controversies ever decided.

The case is big in the conflicting elements; the navigable integrity of the world's most important inland waterway operated jointly by the United States and Canada on the one hand, and the interests of the great State of Illinois with its waterway project to the Mississippi, and the health and well-being of the second largest city of the land in the disposal of sewage and the protection of its water supply, on the other.

It should be immediately stated that it is unthinkable that the Federal Government will ever use its great power to menace the health and safety of the people of Chicago and the suburban communities comprised within the Sanitary District. The modification in the method for the continuance of pure drinking water and the avoidance of an evil-smelling canal and river must be accomplished over a period of some years. Chicago must eventually have a purer and clearer drinking water than now; and the Drainage Canal and the Illinois River must eventually be less offensive than they are at the present time. And the strong arm of the Federal Government will doubtless work with the strong arm of Illinois itself to bring about these most desirable things—and without permanent injury to the navigable capacity of the Great Lakes.

The writer has perhaps had unusual opportunities to view both sides of this controversy and look upon the equities of each party judicially and humanly. He was Advisory Expert Engineer for the United States on all the physical questions of a hydraulic nature, which resulted in a demonstration of the exact amount in inches by which the channels of the lakes would be shallower by reason of the new outflow canal at Chicago. Then after the court case was closed, the Sanitary District retained him as hydraulic engineer to design regulating works to restore the impaired channel depths by throttling the outflow rivers, Niagara and St. Lawrence. During the progress of the litigation the relations between the lawyers and expert engineers of the two sides were always cordial. It was really a friendly suit to decide whether the State of Illinois, through its police power to safeguard the health of its people, could use such methods as would injure the navigable capacity of the interstate and international navigable channels of the Great Lakes—of which the Federal Government is guardian. And the comity and good feeling which should mark the relation between a single sovereign state and the constellation of all the states always prevailed. It was not remarkable therefore that the expert of the United States during the litigation should become the expert of the Sanitary District afterwards, with the acquiescence of the former.

It is assumed that the readers of a journal published in Chicago are familiar with the physical features of the Drainage Canal. It is a great canal cutting across the low divide, separating the south end of Lake Michigan from the headwaters of the Des Plaines River—which is a tributary of the Illinois River which in turn leads to the Mississippi River and the Gulf of Mexico. This low divide marks an old outflow channel by which Lake Michigan drained to the Gulf in some prehistoric geological epoch. The drainage canal water is therefore in a way the return of a son much more prodigal earlier than now. The capacity of this great Drainage Canal, as now cut through the rock divide, is about 14,000 cu. ft. per second, which is about four times the volume of normal flow of the Mississippi River at Minneapolis, the water power city of Minnesota.

The Chicago River, which in the earlier days constituted a little harbor and was the focus about which the city grew, is reversed now, and instead of pouring a sewage-polluted stream into Lake Michigan, serves to suck in from the lake a stream which has the effect of always directing clean, decent water against the city shore-line, and keeping the intakes of the water supply of Chicago almost always in the current coming from the deep mid-lake storage. Branch canals reach up towards Evanston and Calumet.

The Sanitary District of Chicago comprises not alone the city, but the suburban communities as well. The district is a child of the state and amenable to state laws. One of the laws which the trustees have felt compelled to obey is the prescribed dilution of the sewage. This is based on the population of the district and must be 3 1/3 cu. ft. per second for each thousand people. This means over two thousand gallons a day for each individual of population—but the industrial wastes, the stock yards contribution of filth and street washings, reduce the strict per capita relation. The amount of water already in use as a diversion from Lake Michigan approaches 9,000 cu. ft. per second. The present Federal permit is 4,167 cu. ft. per second. The trustees, between the devil and the deep sea of Federal Law and State law, obey the State law.

It may be illuminating to review briefly the circumstances, out of which Chicago's outlawry grew and mention some mitigating circumstances. It should always be understood that in thinking of the Sanitary District we must think of the people comprised within it as the multiple proprietors, and not the trustees who serve the people briefly and in succession as their representatives. If in the past any trustee may have existed whose attitude was arbitrary or short-sighted, that must be forgotten; and the thing to be remembered is that nearly three million people now have a problem on their hands to be solved as of today and tomorrow without any reprisals for yesterday.

At the time (1889) of the inception of the Drainage Canal as the best solution of Chicago's water-supply and sewage disposals problems—conditions were very different from the conditions today in many respects. Sewage disposal as an art was not far advanced—the digestion of crude sewage by the action of running water was the prevailing method. This digestion is still regarded as a proper use of the potentialities of streams. The navigation of the Great Lakes was

comparatively small, with the vessels themselves drawing only 13 or 14 feet of water. The hydraulics of the outflow streams had not been developed and the lowering effect to come with the diversion at Chicago was more or less an academic bug-bear. Water power at Niagara was in its infancy and the water used there was used wastefully. The plant begun at Niagara in 1890, was designed to take only half the energy out of the water used. Water economy was not considered necessary.

So Chicago just started in to take this great volume of water out of Lake Michigan, without any definite arrangement with the United States to do so. With the characteristic optimism of the booming metropolis of the West—millions upon millions of dollars were poured into the great enterprise. The officers of the United States knew about it and did not stop it. It just went on with the confident assurance that the water would be forthcoming when opening day came.

Now, it is rather odd that other great enterprises in the Great Lakes system did much as Chicago did—were initiated and operated under State Charters, even when they affected injuriously the navigable waters of the United States and Canada. The water power enterprise at Niagara Falls—the tunnel project—was built, and operated for a number of years on State Charter without Federal permit; and 8,600 cu. ft. of water per second were diverted. This slightly lowered the Niagara River, and injured very insignificant navigable channels—but the principle was the same as at Chicago. The one great difference between the Chicago diversion and others is that others return the water to the Great Lakes system—while Chicago abstracts it for good.

Well, Chicago should, back in 1889, have secured Congressional sanction for the 10,000 cu. second-feet of water she expected to take out of Lake Michigan—but she did not do this. And as time went on and the various Secretaries of War did not feel warranted in issuing permits for more water than 4,167 cu. ft. per second, partially because the injury to navigation was international in its effect on Canadian channels and partially because the question was too big for an official determination, some of the Sanitary District trustees became defiant and openly stated that they would take all the water that they could get through the canal—14,000 cu. ft. per second or more—despite the restrictions of the Federal Government. Of course this attitude created very bad feelings between the District and the War Department. It should be noted that the attitudes of Secretary of War Taft, and later Stimson were very fair. They simply said that the hurtful effect on the Great Lakes was so pronounced that it became a matter for Congress to settle.

It is certain that the position of the United States is sound and fair. The diversion of 10,000 cu. ft. of water per second at Chicago will lessen the cargo carrying capacity of each of the big vessels about 400 tons on each trip. This is a substantial damage. The loss in water power at Niagara approximates 300,000 electric horse power; and on the St. Lawrence perhaps 200,000 electric horse power. Very little of this loss is made up as the water goes towards the Mississippi River. This power loss means not so much at the present time as it will twenty-five or fifty years from now. It is quite clear from these statements of damage why no officer of the United States wished to assume the power to permit these great national and international injuries and losses—and that each referred the matter to Congress. It appears now that Congress will grant Chicago the right to divert 10,000 cu. ft. per second—enough to care for the sewage dilution of a 3,000,000 population—but no more; and that this permit should be conditioned on Chicago's furnishing the funds—two and a quarter million dollars—to build regulating works on the Niagara and St. Lawrence Rivers—as designed by the writer—to restore the impaired channel depths; and further conditioned on Chicago's adoption of a definite program of artificial sewage treatment to lessen the nuisance in the canal itself and in the Illinois River as the population increases.

It is now definitely accepted that in the Treaty of 1909 with Great Britain, certain divisions of the water of the Great Lakes were agreed upon, which took into account, but did not authorize, a diversion of 10,000 cu. ft. per second at Chicago. Congress may therefore now act without the embarrassment of international complication which appeared inevitable before this fact concerning the treaty was clearly apprehended.

This article would not be complete without stating that legal steps are contemplated by the District—looking to a modification of the injunction of Judge Landis—and that the court may assume the responsibility which the War Secretaries have felt should be borne by Congress. The case will doubtless be appealed to the Supreme Court of the United States.

PRESENT STATUS OF MACADAM BASE FOR BITUMINOUS PAVEMENTS

By Julius Adler, Technical Engineer, Atlantic Refining Co., 1211 Chestnut St., Philadelphia, Pa.

There has recently been a marked revival of discussion devoted either partly or exclusively to the value of macadam and bituminous concrete as foundations for use under asphalt pavements of various types. While the two kinds of base mentioned have some points of similarity, there are essential points of difference, and what follows has reference only to macadam and closely related types. An analysis of these discussions shows the following advantages claimed for this type of construction:

Advantages of Macadam Base

1. Economy in utilizing existing macadam pavements.
2. Lower cost (depending upon available materials, labor, rates, etc.) of construction of new macadam base as compared to Portland cement concrete.
3. Freedom from the transverse cracks which develop in bituminous surfaces on Portland cement concrete, due to the contraction and cracking of that type of base.
4. Slight "resiliency" of the macadam base, which reduces the hammering or anvil effect produced upon an asphalt surface laid on an unyielding base.

A considerable number of the statments above referred to have issued from disinterested sources and the following quotation from an article by a City Engineer of a Southern town is fairly typical of the viewpoint of those advocating the use of macadam and similar foundations, either old or newly constructed:

Why One City Engineer Abandoned Concrete Base

"From long experience and observation of the behavior

of bituminous pavements laid both over a concrete base and over a well constructed macadam base, this department has concluded to abandon the use of the concrete base for bitulithic and other types of bituminous pavements. The reason for this conclusion is that bitulithic actually stays put on a macadam base very much better than on concrete. A properly prepared macadam foundation is quite elastic. It absorbs a considerable portion of the shock of heavy auto trucks and does not throw the entire burden of impact upon the wearing surface. Use is made of the old macadam roadway surface to the fullest practical extent. The grades and crowns for the new pavement are adjusted so as to disturb the old macadam roadway bed as little as possible."

Numerous quotations similar to this could be drawn from both printed and verbal discussions by engineers to illustrate the same point, and examples too numerous to mention are cited of the successful use of bituminous pavements on this type of base from Southern Canada to Florida.

Use of Macadam Road as a Base

In contrast to this viewpoint is the growing tendency in some localities to disregard the possible value of the macadam road for use as a base, the explanation usually being that it is inadequate under all year round heavy motor truck traffic. In such localities the macadam road is perhaps, without exaggeration, regarded as a sort of necessary evil, the best examples to be maintained by bituminous surface treatments until conditions permit of removal and complete replacement by a new type of construction, while those less acceptable are replaced as speedily as conditions permit. In support of this position are the reports from a number of localities of serious damage to both macadam roads proper and macadam base types during the winter of 1919-20.

Between these two opposite and extreme viewpoints there must undoubtedly be a proper course of action dependent upon a number of conditions and taking into consideration both immediate and ultimate economy in expenditures. Obviously, with the great extent of territory in which macadam roads may be found, with the wide variation in climatic conditions, and in volume and weight of traffic (both of the latter frequently occurring within a comparatively limited area), broad statements in regard either to the merit or lack of merit of a given type of pavement should be made with caution, since they may too often be based upon strictly local examples of construction whose success or failure may have been attributable to strictly local conditions.

Factors Affecting Strength and Durability

The solution of the problem of determining the limitations of a given type of paving construction lies in first establishing the factor affecting its strength and durability, and second the application of these factors to a specific case of proposed construction—the latter, it must be admitted, being very often a difficult matter.

In the present case these factors are as follows:

I—Strength of the base.

II—Variation in supporting power of the earth sub-grade.

III—Volume and weight of traffic.

Strength of Base

Under this heading is included such elements as (a) total depth and degree of consolidation of the base, (b) the size of the units used as aggregate, and (c) the strength and durability of the aggregate.

In the matter of depth of base, it is of course generally recognized that other things being equal the greater the depth the greater the area to which a given load is transmitted.

Degree of consolidation, as an item under Strength of Base, refers to the thoroughness with which the pieces of aggregate have been pounded into place during the process of construction and especially by the action of traffic. In this connection it is generally conceded that macadam which has actually carried traffic, if only for a comparatively short period of time, is more reliable from the standpoint of consolidation than that which has been compressed only by means of a roller.

Under size of units of aggregate there must be considered the relative value of a base consisting of small pieces of stone, say 1½ in. in diameter and less, or one consisting chiefly of coarse or ballast-sized stone, and finally of a base in which large pieces are employed such as the Telford type, or the stone "sub-base" frequently used in New England, New York and elsewhere.

Results in general point very clearly to the greater value of the base employing the largest possible size of aggregate, affording as it does greater stability and better distribution of loads, freer drainage and less disturbance by frost action.

Under strength and durability of the aggregate is considered the quality of the material composing the aggregate itself. Exetremely soft, shaley or rotten stone and very porous grades of sandstone and similar materials will, in course of time, disintegrate under combined traffic and frost action. In general, however, it is pretty well established that no such degrees of hardness and toughness are required for the base material as for the aggregate composing the wearing surface.

Variation in Supporting Power of the Earth Sub-Grade

Observation of failures of macadam foundations shows that in the last analysis this factor is usually the one causing the most serious damage. The supporting power of the sub-grade is evidently affected primarily by the character of the soil, by the natural and artificial provisions for drainage and by climatic conditions, including the amount of rain and snow-fall, depth of frost action and likelihood of alternate freezing and thawing.

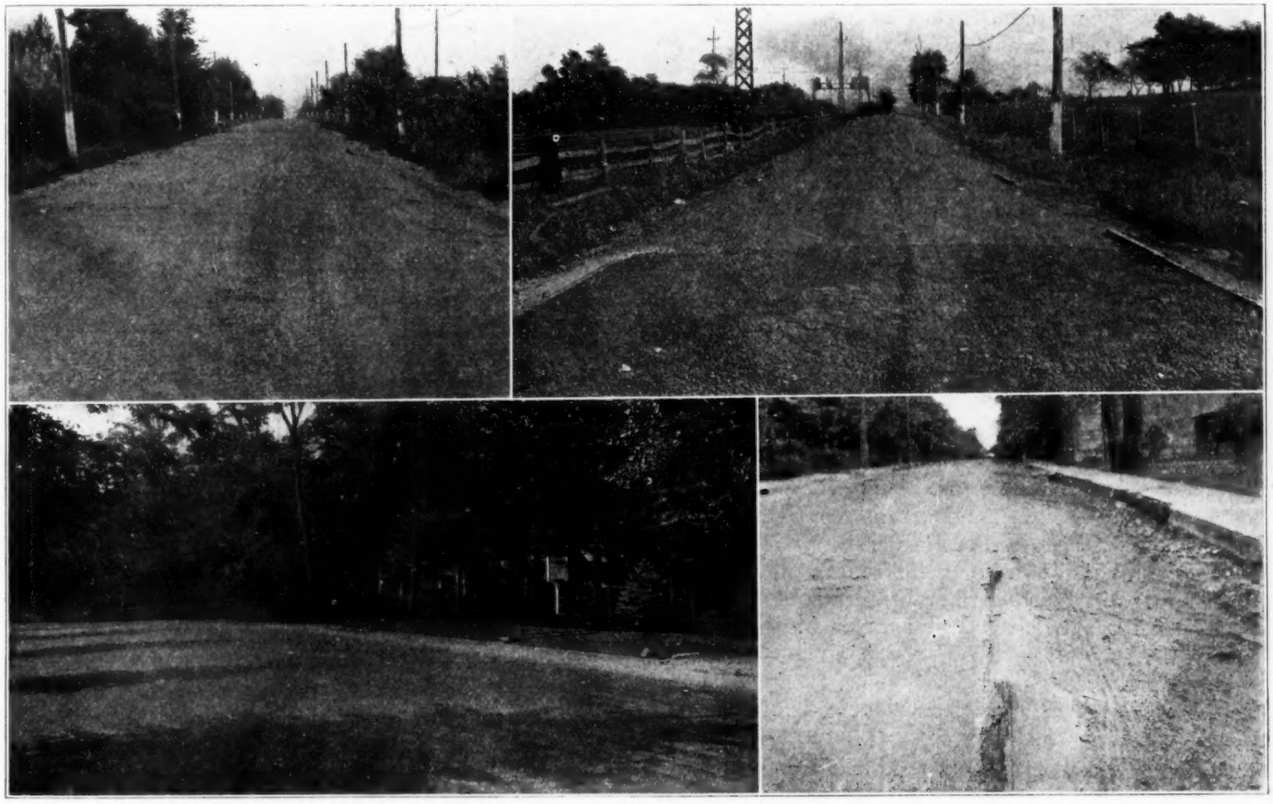
In past years when the well-built macadam road might have been called the most approved type for all but city use, examples of its surprising beam strength, with sub-grade support removed, were frequently discovered. For present day traffic conditions, however, wherever motor trucks are using the roads, the beam strength of the usual macadam base must be considered as nearly negligible; in other words, there must be reasonable assurance of nearly uniform sub-grade support for any except possibly foundations made up of a considerable depth of large or Telford size stone.

The character of the soil is clearly all-important in this connection. Free draining, sandy and gravelly soils form, as is generally understood, vastly better sub-grade than retentive clay soil, and in certain localities there are astonishing examples of extremely light macadam bases laid on free-draining sub-grade of the sort referred to, and carrying considerable traffic with entire success.

Where the location of the road and character of the soil are such that natural drainage is poor, all forms of artificial drainage should be provided. Every discussion on proper road construction has from time immemorial included a statement in regard to the prime necessity of good drainage, while at the same time conceding that it is a sadly neglected feature. Whatever may have been the necessity for proper drainage under the traffic of the past, it was never half so essential as it is under the heavy loads of today. That considerable improvement in the uniformity of supporting power of the sub-grade can be effected through provision for artificial drainage, is definitely established, and in many cases a macadam base now giving unsatisfactory service can be made entirely satisfactory. This will undoubtedly leave a small percentage of extreme cases where poorly drained heavy clay soil conditions in flat sections subject to severe frost action will represent a combination of circumstances under which the average macadam base will have insufficient strength under heavy traffic units, even though the prevailing methods of sub-drainage are provided. Such conditions, however, are likely to prove a severe test of the strength of any type of base of ordinary strength or thickness.

Alternate freezing and thawing resulting in the condition of soft, thawed outlayers overlying hard frozen ones, together with the usual heaving effects, etc., produce a very serious lack of uniformity of supporting power unless the sub-grade can be kept nearly dry throughout the winter.

In contrast with this condition there may be cited numerous examples of roads preserved in localities where after winter has once set in, the temperature remains uniformly low enough to keep the earth in a frozen condition, thus preserving its supporting strength, and eliminating the possibility of the percolation of water into the soil during this period. When this condition prevails, the critical time for the base is limited to the period during the spring, when the frost leaves the ground, and the danger of breaking up is consequently much reduced as compared to the road which is subjected to the possibility of several alternate freezing and thawing periods during a single winter.



VIEWS ILLUSTRATING THE USE OF MACADAM BASE FOR PAVEMENTS.

Top Row: Macadam Base with Clean, Slightly Rough Surface. (Consolidated Macadam, about 22 ft. Wide for 18-ft. Asphalt Pavement)—Binder Course (in Foreground) and Prepared Base. (Consolidated Macadam Extends Almost to Ditch Lines.)

Bottom Row: Asphalt on Macadam Base, with Wide Surface. Treated Macadam Wings. (A Desirable Combination, Giving Excellent Results on an Important Suburban Thoroughfare.)—Effect of Weak Shoulder. Lack of Support Permits Spreading of Pavement Under Heavy Truck Traffic.

Volume and Weight of Traffic

Traffic records over the past five to ten years, especially in thickly populated sections and near large cities, show enormous increases in the volume of traffic over trunk line highways. Accompanying this increase in volume of traffic has been the much more serious matter of increase in weight of the traffic unit, resulting in the use of many of our old roads by concentrated loads several times greater than the heaviest experienced in former years.

From the standpoint of the integrity of the macadam base, probably the most important point is that of the likelihood of the use of the road by the loads in question throughout the year. In rather cold, mountainous or

thinly populated sections where the traffic practically disappears through the winter, and does not reappear in quantity until well on into spring, at a period when the sub-grade is pretty well dried out, the damage by this type of traffic to the macadam foundation may be relatively slight, while in general the most severe damage is found in localities where the heavy motor truck uses the roads throughout the year, and more especially during the months of February, March and April.

Suggestions for Improvement

Assuming the foregoing outline to be a correct analysis of the elements which affect the supporting value of the macadam and similar types of foundation, the problem remains of applying these factors to an individual case, and attempting to determine in advance which ones would be likely to limit the life of the foundation and the overlying pavement.

Since each of these elements will vary with every individual case, only general suggestions and recommendations can be made to aid in their application.

In the matter of strength, it will be found that recent recommendations as to the minimum permissible depth of a base of this type vary from as low as 4 to as high as 12 ins., depending somewhat on individual opinion as well as upon the soil and drainage conditions, etc., affecting the given piece of work. In general there has been a decided tendency to overestimate the depth of existing bases, arising largely from the belief that the annual practice of "dumping stone" on the road over a period of years has resulted in building up a very considerable depth, and failing to take into consideration the fact that usually an equal amount was removed by traffic. This, of course, suggests that, in the use of old roads, a careful survey of the depth of the road should be made by means of test holes, giving an idea, not only of the depth, but also of the character of the existing aggregate. Examinations of this sort will show many old roads containing an average depth of 6 to 8 ins. (in some localities, much more) of compacted stone—these being the ones that are well worth saving.

In general, no radical view should be adopted as to the least thickness of base which will support the proposed pavement since there are few localities in the northeastern half of the country, and especially near large cities, where a total depth of base of 4 to 6 ins. (as sometimes recommended) will be sufficient. The writer believes, however, that even where an ample depth of stone is found, it is usually desirable on old roads to add a uniform layer of ballast-size aggregate which will serve to elevate the proposed bituminous pavement above the level of the old base which, due to the large amount of dust and fine material usually contained, is very likely to hold a considerable amount of moisture in its capillary voids at certain periods in the year. The objection usually offered to this is the danger of disturbance of the old consolidated road; and while in a general way this principle is undoubtedly correct, on the other hand the old road which will not stand disturbance for the depth of 2 or 3 ins. required for scarifying, before the addition of a new layer, will generally not be adequate in depth for use as a foundation in any case. Furthermore, the greater regularity of contour of the base to which a complete new layer of aggregate has been added, will be found to more than offset in the life of the bituminous pavement the original advantage of paving over a slightly better consolidated, but irregular base, which is likely to produce a pavement of irregular contour. Finally, consolidation can usually be completed by admitting traffic, under restriction, over the completed base.

In the matter of supporting power of sub-grade, a very considerable improvement over the existing conditions could be looked for from the adoption of the principle that in the utilization of existing macadam as a base for bituminous pavement, at least as much provision should be made for drainage as though an entirely new piece of road were to be built over the same character of sub-grade. This, however, is not generally done. Too frequently shallow ditches, ditches too close to the improved surface, sections requiring special drainage, etc., are likely to be allowed to remain without improvement. Recent reports from England are to the effect that macadam foundations under bituminous pavements are giving entirely satisfactory service, due to systematic attention to and improvement in drainage conditions.

One Type of Failure of Macadam Base

One type of failure of the macadam base has been the squeezing out and breaking up of the sides, due to combination of too little lateral support at the shoulders, the softening of the sub-grade under the edges of the pavement due to entrance of water, and, in general, failure to recognize that the sides of the road are frequently thinner and weaker than the central portion. As one means of overcoming this condition, it is believed that the thoroughly consolidated base of full depth should always extend at least 1½ to 2 ft. beyond the edge of the pavement laid upon it. If the improved surface is of reasonable and adequate width to accommodate traffic, it will then be found that the thrust on the foundation from heavy, slow-moving loads travelling on the sides of the road will meet with much greater resistance than is now encountered. If, however, the improved road is so narrow that heavy traffic is constantly cutting off and on, damage will naturally continue to result.

Waterproofing Shoulders

As a further step toward improvement, some means of waterproofing the shoulders, at the same time furnishing support at the edges of the bituminous pavement, should be provided. Cases have been noted where the existence of an old macadam shoulder even though rather thin, has been of material benefit. Well built stone block or rubble gutters and headers produce a similar result. If no better provision is to be made, all stone removed from the old surface should be used to harden the shoulders and additional aggregate brought in where required.

One of the best pratices in this connection on country roads consists in the construction of bituminous macadam wings three or more feet in width providing waterproofing and lateral support to the pavement, and at the same time furnishing a hardened surface capable of carrying occasional loads. At the least, however, there should be along each edge of the pavement a strip of hardened surface having the same width as the 1½ to 2-ft. extensions of the base previously referred to.

Width of Pavement

This recommendation may be criticized on the basis that it calls for the construction of a road of a greater width—with a consequent reduction in economy—than

would be required if some other type of construction were used, but in its support may be said that the change from an approved width of perhaps 15 ft. for two lines of traffic, only a few years ago, to the present situation where 20 ft. is frequently mentioned as being desirable, points unmistakably to the necessity for providing ample width at the outset on roads near large centers of population. It may further be added that there is reason for believing that many roads of other types built to widths of 16 and 18 ft. will eventually need protecting wings, not only for the accommodation of additional traffic, but the preservation of the pavement, as well, since at best a sudden drop-off from a hard surface to a soft earth or clay shoulder, is objectionable from several standpoints.

In a number of instances, the depth of the ditch and its distance from the edge of the improved surface appear to play an important part in the strength of the macadam foundation. If too close to the edge of the pavement, open ditches allow moisture to get under the base and reduce the support; if far away, leaving a wide unwaterproofed shoulder, there is too much opportunity for the entrance of water through the surface, especially at times when the ground is heavily blanketed with snow or ice. The absence of these pervious shoulders is noticeably beneficial in city and suburban streets paved from curb to curb. It is, therefore, believed that for country roads a shoulder about 5 or 6 ft. wide, with provisions for waterproofing between the edge of the road and a point near the edge of the ditch, represents the most desirable arrangement.

Summary

To summarize the foregoing discussion, it is believed that proper preliminary studies will make it possible to determine those cases where a macadam base for a bituminous pavement, would at best, be positively inadequate, and the steps which will be necessary in all other cases to place them in proper condition for use; that (in contrast to the old desire to make use of the macadam with as little expenditure as possible) greater attention to and provisions for proper drainage and thickness, admitting the present limitations to the knowledge of the matter of drainage, will still, in a large proportion of cases, establish the desirability and economy of utilizing existing macadam as a foundation for bituminous pavements.

The foregoing paper by Mr. Adler was presented at the recent annual convention of the American Society for Municipal Improvements.

RECENT EXPERIENCES WITH WOOD BLOCK PAVEMENTS

By Herman von Schrenk, of von Schrenk and Kammerer, Consulting Timber Engineers, Tower Grove and Flad Avenue, St. Louis, Mo.

During the past two years numerous failures of one kind and another have been experienced with wood block pavements. Following periods of heavy rain-fall during the summer of 1919 and at various times during 1920, wood blocks buckled and heaved and in some instances on long stretches of city streets the blocks floated away entirely. There has also been an increase in the number of cases of failure by decay of supposedly well treated blocks. Cases of excessive bleeding have also been reported, but less frequently than in former years. In addition to the foregoing a case has been reported of blocks shrinking excessively to such an extent that the blocks became loose in the streets. In view of these difficulties, particularly when taken in connection with the difficulty of obtaining both proper timber and creosote oil for its treatment, it is possibly not surprising that wood block paving has dropped somewhat in the estimation of some engineers.

Wood Block Troubles Within Control of Engineers

These failures, so far as the writer has been able to examine them, have been due, not so much to any inherent defect of creosoted wood blocks as such, but almost wholly to conditions entirely within the control of the engineer. Many valuable lessons have been learned as a result of these failures and in the following it will be the endeavor of the writer to give a brief analysis of the underlying causes with some suggestions as to how these may be prevented.

Divisions of the Problem

Any consideration of wood block paving may be grouped under these five headings:

First. Kind of timber to be used.
Second. Condition of timber.
Third. Preservative to be used.
Fourth. Treatment.
Fifth. Laying.

In 1916 the Committee on Specifications of the A. S. M. I. adopted specifications for the timber, condition of the timber, the oil to be used in treatment, and the treatment of wood block paving (see Proceedings 1916, pages 588 to 608). These specifications are in effect today with the exception of certain slight changes in the specification for preservative presented and adopted in 1918 (see Proceeding 1918, page 371). At the 1919 convention, the chairman of the Committee on Standard Specifications for Wood Block Pavements made the statement that these specifications appeared to be satisfactory and would insure a good, substantial, lasting block.

Taking up the individual headings:

Timber

Where the present specifications of the A. S. M. I. have been followed as to the kind and quality of timber, a reasonably dense, satisfactory block has been obtained and few, if any, failures have been reported because of the character of the wood used. In view of the failure of the sap wood of treated blocks, the writer has had numerous inquiries as to whether sap wood after all was not to be treated as a serious defect in a paving block. Sap wood as such, if sound, has all the strength qualities of heart wood. A study of the relative strength of sap and heart in Douglas fir shows that practically the weakest wood in the tree is in the center of the heart. The difficulty with sap wood is in the nature of the treatment rather than because it is sap wood.

Preservative

Preservatives used during the last few years, while they have not always been in accordance with the specifications of the A. S. M. I., have been more or less satisfactory and there has been very little complaint. The statement made by the writer before this organization in 1915 that the preservative is not the most vital part in

a successful wood block paving holds today as well as it did then. Where a good coal tar product is used with a fairly high percentage of high boiling compounds, failures will be few and far between; in fact, the writer has yet to see any failures of blocks due to the oil used where such oil was a pure coal tar compound.

Treatment

The treating specifications as at present prescribed have proven satisfactory in every way and there seems to be no reason to ascribe any of the recent failures to treatment.

Condition of Timber

The present specification provides that "the timber may be either air-seasoned or green, but should preferably be treated within three months from the time it is sawed." Recent experiences indicate that it may possibly be desirable to modify this clause to put a greater emphasis upon the necessity for having timber as thoroughly air-seasoned as possible—in other words, with a minimum moisture content. Reference has been made to failures due to decay. In 1915 the writer discussed in considerable detail failures which had taken place in various cities due to the decay of the sap wood of treated blocks and showed that this decay was due almost entirely to failure to obtain proper sap penetration. The sap decay of creosoted blocks has become more evident, not only on the streets then reported on, but on many new streets. Attention is again called to the fact that proper lasting cannot be obtained unless the blocks are thoroughly penetrated with the preservative, meaning by this at least perfect penetration of every part of the sap wood. Penetration throughout the sap wood can only be obtained in all cases if the blocks are as dry as possible. There is no question whatever but what many of the failures to obtain complete sap penetration are due to the fact that the blocks are not thoroughly dry and that water pockets were still present in the sap wood, thereby preventing complete penetration of the preservative. There is of course no use for laying a block pavement if one cannot be reasonably certain that it will be protected against decay so as to give the maximum length of life. No amount of steam treatment will make possible equitable distribution of creosote oil in a wet piece of wood. In this connection, it may possibly be of interest to explain that the initial steam treatment of paving blocks is for the purpose, not so much to get rid of water, as to assist in the driving out of the air, which is the principal factor causing bleeding after the blocks are laid in the street. Even if the use of thoroughly air-seasoned material did not appear warranted because of conditions to be described presently, it would nevertheless be necessary and desirable to treat air-dry timber for the sole purpose of getting better penetration than has frequently been obtained in the past.

Inspection

The present specifications of the A. S. M. I. call for careful inspection of the blocks after treatment by sawing a number of the blocks taken at random at right angles to the fibres through the center of the block. This is practically the only way in which one can detect the extent of the penetration of the preservative. In view of the sap failures, I strongly urge that at all times this method of inspection be rigidly followed at the time of treatment.

Laying

By far the largest number of failures of wood block paving in recent times has undoubtedly been due not to the blocks, but to the manner in which they were laid in the street. So much has been written about this subject in the past two years that it will hardly be necessary more than to indicate the present state of our knowledge of this exceedingly important factor. In the early days of laying creosoted wood blocks when more or less rough concrete foundations were used, the sand cushion came into use largely to give a smooth base on which to lay the blocks. During the period of its more extensive use difficulties of all sorts arose. The blocks bulged in spots after rain-falls, and after very heavy rain-falls whole street sections floated away. In many cases curbstones were thrown out of line. Another difficulty occurred due to the shifting of the sand base, giving irregular depressions and frequently holes. It has long been realized that the employment of the sand cushion was largely responsible for the unwelcome swelling and the displacement of curbstone and surface. Water found its way between the individual blocks and was absorbed by the sand at the bottom of the blocks. The latter then swelled more at the bottom than they did at the top with the resultant disturbances.

It is this unequal swelling of the blocks that has probably been the greatest factor in the failures during the past two years. So common have these local eruptions become that they are considered by some to be a necessary evil in connection with the wood block. In spite of the fact that these experiences are now of many years' standing it is surprising to find how many cities still use the sand cushion, particularly in view of the excellent results obtained in many cities with other methods.

Chicago Experience

As a result of experiences with the sand cushion, a number of cities adopted the plan of laying blocks directly on the concrete base either with a thin cushion of sand-cement mortar or frequently on a perfectly smooth concrete with a bituminous coating. The first street of this sort laid was Dearborn street, Chicago, between Adams street and Jackson Boulevard, put down in 1914. The east half of the street was laid on a mortar cushion and the best side on a smooth concrete base with a bituminous coating. The writer is indebted to Mr. Gabelman, Engineer of Streets, Chicago, for the following report on this street: "At the present time the west side of Dearborn street from Adams street to Jackson Boulevard is in excellent condition with the exception of a couple of cup holes. Two yards of maintenance would make it perfect. This side of the street is where the heavy trucks unload mail and should show much more wear than the east side of the street. The east side shows much more wear and is very uneven and is full of depressions."

Some St. Louis Experiences

Another street with which the writer is familiar, laid shortly after (1915), is 15th street, St. Louis, between Olive and Washington. This was laid on a concrete base prepared with a smooth finish, painted with pitch and the blocks laid directly on the pitch after it had cooled. It was then rolled with a light steam roller and the joints filled with pitch. This pavement is still in perfect condition. Very few pavements of this sort were laid, how-

ever, until comparatively recently. The abandonment of the sand cushion was followed most frequently with a sand-cement cushion, laid dry and moistened immediately before the laying of the block. In many cases this has not come up to expectations. If the sand was at all moist at the time of laying, a very poor bond was formed and the mixture acted practically like a sand cushion.

With the introduction of the smooth concrete base with a bituminous coating on which the blocks were laid directly, have come another series of problems of an entirely new character. In laying blocks on a sand cushion or on a sand-cement cushion, a filler of some sort was always specified to guard against admission of water between the blocks. Experience has shown, however, that even with the best care there was always sufficient space left to allow the water to percolate to the base of the blocks. Here it would stand for a short time and then be gradually absorbed by the base of the blocks, causing them to swell with consequent uneven expansion and heaving. With either the sand or sand-cement cushion there is, in other words, a material holding water in immediate contact with the highly absorptive lower surface of the blocks as distinguished from the bituminous surface which absolutely prevents water absorption. In some cases (see Horner, Engineering News Record, April 22, 1920) the filler when softened under extreme street temperatures, flowed down under the blocks in an irregular manner and increased the chances during sprinkling or rain-storm for water admission to points immediately underneath the blocks. With the use of a bituminous coating on a smooth concrete base, particularly after the blocks were rolled, an almost water-tight condition obtained at the bottom of the blocks. Explosions after rain-storms such as occurred on previous types of construction happened very rarely, if at all, on the bituminous concrete base. Blocks, in other words, were more or less protected from water on all sides except on the top. The amount of water absorbed on the top by the blocks was very small and usually disappeared rapidly by evaporation after the rain or sprinkling. There was practically no tendency for the blocks to enlarge. On the other hand, it was found in a number of cases that blocks thus protected from water absorption lost the water during periods of high temperatures in summer and tended to become loose. This condition is very elaborately described by W. W. Horner, Chief Engineer of Paving, St. Louis, in Engineering News Record, April 22, 1920, page 814. Three streets are described in this article. The blocks were laid on a smooth concrete surface, mopped with pitch at 140 to 145 deg. melting point and the blocks laid after the pitch had cooled. shortly after laying, the blocks contracted and became so loose that they had to be taken up out of the street, cleaned and relaid. On another street laid about the same time, where it was shady and the rate of evaporation of the water from the blocks was very much less, little difficulty was experienced as to shrinkage.

In the Oct. 7, 1920, issue of Engineering News Record, Mr. Horner describes the action of one of the streets last referred to, which had been laid in the summer of 1919 after the relaying of the street first mentioned where the shrinkage had been so high. The blocks in this second street were laid very tight, anticipating a possible shrinkage. In June of this year these blocks began to shrink just as they had on the street first mentioned. With an extremely ingenious device, fully described in the article cited, Mr. Horner took up the shrinkage, which amounted in one case to a total of 1.3 ft. in 125 ft. Careful attention is directed to the extremely interesting details presented in the article referred to. After the complete closure of the blocks on this street, with terrific rain-falls coming early in September, there was not the slightest movement on the pavement in any direction. An almost ideal condition has been obtained, namely, blocks were protected against water at the base by the pitch coating, on all sides by the pitch filler, and the tops of the blocks, while not quite as effectively waterproof, absorbed only small quantities of water which disappeared rapidly after the sun came out. In other words, the heaving effect due to the absorption of water at the base of the block was almost entirely obliterated.

Water Absorption and Water Loss

The great trouble breeder with wood block paving, aside from the question of bleeding, has been water—water absorption and water loss. Water absorption causes expansion which, when it takes place unevenly as it has done in the cases of the use of sand cushions and frequently sand-cement cushions, brings about upheaval in the pavement and entire destruction of the street during heavy rain-storms. Water evaporation has caused loose blocks and a constantly disturbed street surface. The ideal condition is one in which the blocks are so prepared that they may have a minimum amount of water in the wood to start with and then to have them so protected that they will have little opportunity for absorbing water. The nearest approach to such a condition will undoubtedly be obtained as indicated by Mr. Horner, by treating as thoroughly air dried timber as can be obtained, then laying the blocks on a smooth concrete foundation with proper pitch surface, taking care to lay the blocks as tight as possible, and then providing a thoroughly acceptable pitch filler. This practice is now being followed in some of the newer streets which have been laid in St. Louis.

Summary

Summing up the foregoing, experiences of the past few years seem clearly to indicate that the proper procedure to obtain maximum service from wood block pavements is to follow the specifications for timber, preservative and treatment prescribed by the A. S. M. I., with possible modification to the treatment specification looking toward the treatment of thoroughly air-dry timber. This should be followed by blocks laid on a thoroughly smooth concrete base with a good pitch coating, blocks laid as tight as possible, with a good pitch filler. When this procedure is followed, there seems to be no reason to anticipate any of the difficulties which have worried the street engineer during the past few years and should once again put this useful material to the forefront in all street construction.

This paper by Mr. von Schrenk was presented on Oct. 14, 1920, at the annual meeting of the American Society for Municipal Improvements.

EXPERIENCE WITH IMHOFF TANKS IN MINNESOTA

By J. A. Childs, Engineer, Division of Sanitation, Minnesota State Board of Health, St. Paul, Minn.

Those in charge of Imhoff tanks have encountered difficulties in certain instances with the operation of this type of settling tank. It may be of interest to record the experience with Imhoff tanks in Minnesota.

First Minnesota Installation

The first plant of this type was constructed in this State in the year of 1911, and since that time approximately 40 municipal and institutional tanks of this type have been installed. This does not include some two or three hundred small Imhoff tanks which have been constructed for the treatment of sewage from school buildings. Data based on experience in Germany was used in the earlier designs. It was soon apparent that the sludge chamber capacity of certain of these earlier installations was insufficient owing principally to the fact that the winters in Minnesota are relatively long and cold. During the cold winter months the bacterial action in the sludge compartments is very much retarded necessitating the holding over of a considerable portion of the sludge for summer ripening. The requirements of the State Board of Health now provide for a minimum sludge chamber capacity, below the settling compartment slots, of 2 cu. ft. per capita tributary to the system. It has been found that adequate sludge chamber capacity in nearly all cases eliminates the difficulty of having to handle partially ripened sludge.

Scum Troubles

Some difficulty has been experienced due to the excessive accumulation of scum in the vents. An instance of this kind occurred at the Faribault Institute for the Feeble Minded. This plant was constructed in the year 1914. The sewage reaching it is fresh and contains a considerable amount of soap and kitchen wastes. Soon after being put into operation, sludge began to accumulate on the surface of the vents until it had reached a thickness of approximately 10 or 11 ft. This floating sludge of scum was removed and instructions were given for the breaking up daily of scum accumulations. These recommendations were complied with and the plant has been in successful operation for a period of between three and four years. The scum in the vents is always loose and seldom exceeds a thickness of 12 ins.

The experience with the Faribault plant illustrates an extreme case where neglect caused the failure of the tank to operate satisfactorily and where intelligent care was all that was needed to obtain good results. The greatest difficulty appears to be to impress the local authorities with the fact that a sewage treatment plant is not an automatic piece of apparatus which can be ignored after being put into operation and expected to operate properly. The experience in Minnesota has demonstrated that plants of the Imhoff type, which are properly designed and intelligently cared for, will give generally satisfactory results. When all things are considered, there appears to be no type of tank treatment at present in general use which so well meets the operating conditions found at the average Minnesota municipality, as does the Imhoff type of tank.

METHOD OF STRENGTHENING AND RECONSTRUCTING HIGHWAY BRIDGES FOR HEAVY MOTOR TRUCK TRAFFIC

[Editor's Note:—The following discussion is the full text of the report of the Committee of the American Road Builders Assoication on the above subject, of which Mr. Willis Whited, Engineer of Bridges, Pennsylvania State Highway Department, is chairman.]

Shall we continue to endanger the lives and property of the people by criminal neglect of the highway bridge?

It has been estimated that more than 80 per cent. of the highway bridges are a distinct menace, due to one of two things—original construction not strong enough for modern traffic demands, or deterioration of the structure.

The life of a bridge is long. Thousands of those now in use were built before the motor traffic era. Failures of some of these structures prove the immediate need of strengthening or replacing these antiquated bridges so that they will carry not only the truck of the present day, but also the much heavier trucks and tractors of 20 years hence.

The motor truck is with us to stay. Its usefulness is steadily increasing, and is being recognized more and more all the time. Nobody who followed the history of the truck trains both in France and in our own land during the war has the slightest doubt of the fact that heavy truck transportation is not a dream of the future; it is an accomplished fact.

Truck Traffic

However, heavy trucks are, generally speaking, efficient only on improved roads, although the lighter trucks can run over dirt roads for a large portion of the year.

As the use of trucks becomes more general, it logically follows that the demand for improved roads will grow more insistent. The bridges on these roads will naturally be strengthened as the roads are paved. However, the use of the branch roads as feeders for the main roads is bound to increase, and it is right here that the engineer must look to his bridges.

The use of a road by loaded trucks is limited strictly and absolutely by the strength of the bridges on that road.

The Motor Bus

The motor bus is following in the wake of the truck. While this does not impose any new burdens from a technical standpoint, it greatly increases the danger of loss of life in case of the failure of a bridge. Moreover, these motor buses do not confine themselves to the main highways, and there will be a constantly increasing tendency to use them on dirt roads for sight-seeing purposes, and for reaching the more remote districts; for instance, the buses that gather up the children to take them to the modern township school, which in so many places has replaced the old district school.

Period of Service

Most of the States have passed laws limiting the weights of trucks, the maximum allowable weight, as a rule, being in the neighborhood of 28,000 lbs. This limit is fixed more to determine the liability of truck drivers and public officials than as establishing a final limit for the weights of trucks. Whenever the economy of heavier

trucks is established, which will be when better methods of constructing pavements and better materials and designs for tires, etc., are introduced, it is fair to presume that the legal limit will be raised.

A well-designed, constructed and maintained reinforced concrete bridge will, as far as we can see, last for centuries. A first-class steel bridge, properly kept up, will last at least 50 years and probably much longer. Trucks considered now to be heavy may appear puny in 1975. The engineer, therefore, is using good economy in looking well into the future in designing new bridges. The cost of the additional strength is a comparatively small proportion of the total cost of the bridge, and is trifling compared with what it would cost to strengthen it when that becomes necessary, as it surely will before very many years. If, however, an old bridge is to be strengthened, it is only a makeshift at best and the engineer is not justified in looking many years ahead in deciding on the assumed loading.

About 400,000 Highway Bridges

In the course of an investigation by a committee of the New York Legislature, it developed that there were in that State, about 33,800 public highway bridges more than 5 ft. in span, which would indicate that there are about 400,000 such bridges in the United States. It is safe to say that the failure of any one of a very large proportion of them would be liable to cause loss of life. It is also probable that more than 80 per cent. are unable to carry a modern heavy truck with a reasonable margin of safety. It will thus be seen what a colossal task it would be to replace all of them with modern structures, and also to what an extent the bridge engineer is the custodian of human life. We will not hazard a guess as to the total cost of such replacement, but it would probably amount to several billions of dollars.

Annual Inspection of Bridges

Every bridge should be inspected at least once a year by a competent man. A majority consist of a single span of wooden stringers with plank floors. In the case of such bridges the main points to be observed are the safety of the abutments, the sufficiency of the width, the safety of the railings, the adequacy of the waterway and the strength and soundness of the stringers and planking. All these points require sound judgment and reasonable amount of engineering knowledge. With the larger bridges the responsibility is greater and the danger of loss of life in case of failure is also greater. Many bridges require inspection oftener than once a year. All steel bridges should be painted every three or four years by competent men who are carefully instructed to report all defects observed. Many parts of steel bridges are not accessible for proper inspection without the use of scaffolding such as painters use. It is not always practicable to employ such scaffolding during the annual inspection. In preparation for the advent of heavy trucks all public bridges should be examined by competent men who will make a record of the character of the traffic likely to come upon the bridge, the dimensions and conditions of all vital members and the sufficiency of the details, and written reports of such inspections should be forwarded to the proper State Department for record. From these reports it must be decided which bridges require complete reconstruction, which require new superstructures, and which can be repaired and strengthened. The necessary plans can then be prepared and should be checked on the ground. Copies of all inspection reports should, of course, be filed with the proper local authorities, especially if they have charge of the bridges, but the State can better afford to employ competent men, and records kept in the State Capitol are less likely to be lost than those stored in local offices.

Strengthening Old Bridges

The strengthening of old bridges often requires far more engineering skill and ability than the design and construction of new ones.

The committee does not consider that in deciding whether any given member of a bridge needs strengthening, it is necessary to hold strictly to the letter of the standard specifications in the matter of unit stresses. In fact, a deficiency of 20 per cent. in material is not serious, provided the details are good and the material is in good condition, it being felt that the usual unit stresses adopted make that much allowance for deterioration, besides secondary stresses, etc., less allowance, however, should be made in the case of floorbeam hangers, stringers and floorbeams which are subject to widely and rapidly varying stresses. In considering the strength of a bridge truss it is not necessary to assume that the bridge is packed full of trucks of maximum weight, but if the bridge is 16 ft. wide or over, it is always possible that two heavy trucks may pass on the bridge.

The committee feels that, in cases where a bridge must be rebuilt or where the strengthening would make it, in effect, a permanent structure, it should be designed to carry a truck weighing at least 20 tons, with no allowance for impact.

Determine and Post Safe Loads

The committee fully recognizes that the immediate strengthening of all bridges in the country that need it together with the reconstruction of those which cannot be economically strengthened is a physical as well as financial impossibility. It would, therefore, recommend that immediate steps be taken to have a thorough examination made of all important structures by competent engineers and their safe loads determined and indicated by proper signs to the end that the public be protected so far as is humanly possible. Any person who disregards these notices and suffers disaster has only himself to blame. The work of preparing plans for strengthening should then proceed without delay so that construction can be taken up as rapidly as possible.

Steel Truss Bridges

The small bridges will generally have to be rebuilt, the steel truss bridges will generally be found fairly strong in the trusses but altogether too weak in the floor system. Many steel bridges have suffered seriously from neglect of painting and maintenance. Very frequently the steel about a foot above the bridge floor is very badly corroded. In such cases tension members would have to be reinforced, which can generally be done if they are of structural shapes, but if the bridge is pin-connected, the bridge can be supported on falsework and new tension members inserted. Corroded compression members can very often be effectually and permanently strengthened by concreting in the corroded parts. The concreting should extend beyond the corroded parts far enough to

secure sufficient adhesion. Defective details will generally have to be corrected, even at considerable expense. The attempt is sometimes made to strengthen a truss by placing another alongside it. If this is done great care must be taken that each truss carries its share of the load. The floor system should be supported on falsework and disconnected from both trusses, which swing free, and then connections should be made to both the old and new trusses. The upper bracing should be connected to the new trusses also to give them lateral stiffness. If the stringers only are somewhat weak their number can be increased at quite a moderate expense. If the stringers are very weak they should be replaced with new ones of sufficient strength. Weak floorbeams can generally be strengthened by riveting on new cover plates. The hangers should be carefully scrutinized for defects as well as for design, and if necessary, replaced with stronger ones.

Miscellaneous Methods

Few of the steel truss bridges are strong enough to carry paved floors, although many can be refloored with 2 x 4-in. creosoted wood set on edge and spiked closely together. This will give a much more durable floor and one much less likely to break through under heavy loads. The weight is but little greater than that of a plank floor.

Plate girders can often be strengthened by riveting on additional cover plates. Riveted lattice trusses can often be reinforced to carry paved floors without throwing away any existing material. Pin-connected trusses can rarely be strengthened and occasions frequently arise where it is necessary to support the floor by means of timber bents, consisting of piles, if the bottom is soft; or by means of mud-sills and posts, if the bottom is hard. If they are used they should be placed under all the floor beams, the outer posts being about 2 ft. inside the center lines of the trusses. This method, of course, is not suitable if the stream is likely to carry much drift wood or floating ice. Timber truss bridges can often be strengthened. If as is frequently the case, the floor only is weak, it is generally possible to put in heavier timber in the floor or to strengthen it with steel to carry heavy trucks. Stone arches are almost always amply strong to carry the load if they are in good repair, but it is sometimes necessary to remove the earth covering and grout the joints between the stones to give them full bearing. Stone arches, moreover, will usually show signs of distress long before total failure. It is rarely possible to strengthen a plain or reinforced concrete arch. If a truss is weak it seldom increases its strength to place bents under the floorbeams unless all the floorbeams are supported in the same way, taking the load almost entirely off the trusses. Plain concrete arches are more likely to fail suddenly without warning than almost any other kind of bridge.

Contract and Day Labor Systems

As to how this work of strengthening should be carried out much depends on circumstances. Estimates of cost are sometimes misleading. Unit costs of repair or alteration work in place are often more than twice the unit costs of similar material in new work. When an engineer starts to repair an old bridge he is almost certain to find a considerable amount of work that must be done that he had not anticipated. For these reasons it is usually best to have the material furnished or fabricated by contract and the field work done by day work if a reasonably efficient gang can be organized. Expensive equipment such as pile-drivers, air-compressors, etc., may be rented on a per diem basis. If it is a well-defined job such as replacing a floor system, or an abutment, it can be done satisfactorily by contract; otherwise a bidder is confronted by the same difficulty as the engineer in estimating his cost and will either bid high to cover risk and uncertainty, or will bid reasonable prices expecting to make up with his bill of extras, which will be no small item. Another difficulty often encountered in a repair job handled by a lump-sum contract may be illustrated as follows: The engineer estimates $10,000 as an outside figure for the job, he secures an appropriation of $15,000 to cover extras; the bidders have no way to estimate accurately their cost and are apt to be guided by the amount of the appropriation and bid about $14,900 leaving far too small a margin for extras. If an efficient gang cannot be organized, the cost plus system is generally the best. One difficulty that must be considered is that of insuring that the work can be done within the appropriation.

Steel truss bridges are nearly always fairly well designed except sometimes the details are weak, that is to say, if they are weak at all, they are correspondingly weak throughout. If it is desired to strengthen them as a whole, e. g., so as to carry a paved floor, it is almost always about as cheap to scrap the bridge and build a new one as to reinforce the old one. Besides if the former is done a modern well-designed bridge of ample strength will result. Otherwise the result will be an unsightly makeshift which will have to be repaired again in a few years.

If a bridge is at the foot of an incline, as is often the case, trucks are likely to cross them at a high rate of speed, which not only increases the stress, but also increases the danger to life and limb, to say nothing of property, in case the bridge fails.

The question of detouring traffic while a bridge is under repair is often quite difficult. It is frequently possible to support the old bridge with bents and maintain traffic over the bridge during repairs, although this method adds considerably to the cost of repairs. Sometimes a timber trestle can be built alongside or in the vicinity.

If a bridge is to be replaced it is sometimes possible to move it bodily sidewise on temporary supports and construct new temporary approaches.

The list of bridges which have failed under heavy trucks, with or without loss of life is a long one. In the vast majority of cases it is only the planking or the stringers which have broken through.

Legal Aspects

The courts have decided that it is the duty of the driver of a vehicle to make sure of the safety of a bridge before he crosses it, a duty of which he is often incapable, it being frequently a highly technical matter. He will usually be guided by experience. If a bridge has been crossed by heavy loads it will be considered safe for the same load again. This may be true and may not, a structure that is overstrained will be weakened thereby, although it may not fail immediately. "The last straw breaks the camel's back."

In submitting alteration plans for bids, they should be made as complete as practicable and should guarantee

all dimensions which the contractor cannot readily verify. Dimensions not guaranteed should be sufficiently accurate to enable the bidders to make close estimates of the quantities of materials required.

All requirements regarding maintenance of traffic, etc., should be clearly stated and if the work must be done at certain seasons of the year or certain days of the week or at certain hours of the day the fact should be clearly stated.

All matters concerning right-of-way, encroachments, etc., which may lead to law suits should, of course, be handled by the local officials; juries are much more generous to the local public than to out-of-town contractors or counties or States. Besides, a law suit is far more vexatious and expensive to a contractor than to the local public.

Giving the Contractor a Fair Deal

It is generally best for the public to assume all practicable risks; i. e., to eliminate the gambling element from contract work so far as possible. Every competent contractor adds to his bid an amount sufficient, in his judgment, to insure against all risks. It is usually best to give him every incentive to reduce the damage from flood and bad weather to its lowest limits. The contract should provide that the contractor should have an extension of time in case the work is necessarily delayed by bad weather, fire, flood or other accident. Similar provisions regarding delay due to strikes, delays in transportation, congestion of the material market, etc., should be contingent on the contractor having, in good faith, done the best he could under the circumstances. Prophetic wisdom should not be assumed to be an attribute of a contractor.

An excellent plan is to allow the contractor a certain number of working days to do the work, the time to be reckoned from the time he receives orders to start work. In that way, proper allowance can be made for bad weather, flood, etc. The principal difficulty in the case of steel work is that the material is frabricated under cover, independently of the weather, and is delivered on the site ready to erect, but there are frequently long delays in procuring the material and getting it fabricated. It would evidently be useless to order the contractor to start work on a job before his material had arrived on the site, and, on the other hand, the delay in obtaining and fabricating the material might be unwarranted. It would, therefore, be better, in this case, to allow a certain gross period for delivering the fabricated material and a certain number of working days for doing the work at the site. The former period would depend very much on the state of the material market and the facilities for fabricating which may be available at the time. This, in turn, would depend somewhat on the magnitude and character of the job. If heavy timber is required there is often a considerable premium demanded for delivery from stock, besides allowance must be made for more or less waste. In such cases, if haste is demanded, a sufficient premium must be allowed for prompt completion to make it an object for the contractor to obtain the required timber from stock. It may be difficult, however, to frame up a legal contract containing that provision. The courts object to paying bonuses on public contracts.

It is good policy to make a job as attractive as practicable to the bidder. A contractor is likely to bid high on a job he does not want very badly. A repair or alteration job is not generally very desirable on account of the large amount of supervision required and the frequent vexatious emergencies that arise, which combine to make the overhead cost all out of proportion to the amount of material used. Besides such jobs require a higher grade of skill and intelligence in the workmen than ordinary pieces of work. A highly skilled workman is likely to get disgusted with that kind of proposition. There is not infrequently much difficulty in finding a contractor who is willing to be bothered with a repair job. Often the best man is a small contractor who has nothing else to do, if such can be found.

Rebuilding a Bridge

If it is decided to rebuild the bridge, a proper investigation must first be made by a competent engineer to determine the required waterway and the type, span and width of bridge to be built. Frequently a new location is preferred, if not, the old masonry must be rebuilt or altered. The old way was to employ a local stone mason who had no proper equipment for foundation work in the river, to put in the masonry. If the bottom was quite soft he would drive piles and saw them off about on a level with the surface of the water, cap them with planks and build rubble masonry upon them. The masonry was usually much too thin with little or no mortar in the backing, due to lack of inspection. The result was that in a few years, the timber foundation decayed and the wall cracked and settled and had to be repaired under circumstances that made it very expensive. If the ground was fairly firm the contractor would excavate a few inches below the surface of the water and build masonry as above described. Sooner or later a flood would undermine the foundations and serious damage if not destruction of the whole structure would ensue.

The modern way is to employ an engineer to design masonry of proper strength and thickness, usually of concrete or concrete faced with stone founded on piles if necessary. The work is let to a contractor who does that kind of work and is equipped with proper pumps, pile-drivers, derricks, concrete mixers, etc., to do a good job in a reasonable time. The foundation is carried to a depth sufficient to avoid all danger of undermining by scour. If piles are required, they are driven and the excavation pumped out so that the piles can be cut off well below the bed of the stream. The excavation is carried some feet below the tops of the piles and filled with concrete enveloping the tops of the piles and the whole masonry carried up to completion. If the bottom is soft, either the bed of the stream is paved or the masonry is protected with riprap. A job is thus completed that will probably last for centuries, at a cost not much greater than by the old way, allowance being made for increased prices of labor and materials. Everything is done under the eye of an inspector supervised by an engineer who insists on an honest workmanlike job. If the superstructure is of concrete or stone it is designed with proper strength and the materials and workmanship tested and inspected so that the public gets a good bridge at a reasonable cost.

If the superstructure is of steel the problem is somewhat different. The old way was to receive bids on a lump-sum basis from contractors who furnished their own plans. The specifications stated the capacity

strength, etc., but there was nobody representing the owner to see that the specifications were compiled with, and the contract was likely to go to the man who had the most "nerve" in skinning down the quantities of material. Little attention was paid to durability or ease of maintenance and the honest contractor was gradually forced out of the business. There was no inspection by any competent representative of the purchaser to see that the workmanship and material were according to specifications, and the contractor was at liberty to play any tricks he saw fit. The bridge was then painted with some cheap and worthless paint and opened for public use. The result was that thousands of bridges have been built with a margin of safety very near the vanishing point and at prices which should have been sufficient to pay for a good bridge.

The modern method is to employ a competent engineer who prepares plans for a bridge which will be as safe and convenient as possible, providing extra material in parts that are peculiarly subject to wear and tear and special protection for any parts that need it and the requisite number of coats of first-class paint. The plans, specifications and information are so prepared as to reduce to a minimum the expenses of the bidder in preparing his bid and to make the job look as attractive as possible.

The work is advertised in the local papers to comply with the law and also in one or more of the periodicals that make a specialty of such work, and are, therefore, widely read by contractors. The advertisement is of reasonable length, but gives sufficient information to enable any contractor to judge fairly well whether he wants the job. Information regarding the work is given to the information bureaus which make a specialty of notifying contractors of work to be let. The engineer also notifies, in any suitable manner, any contractor he knows who could handle the work. This last should be done in such a way as to prevent any combination being formed among the bidders. After the bids are opened and the contract duly awarded according to law, the contractor prepares his shop drawings and submits them to the engineer for approval, after which they are signed by the proper officers, including the engineer. The contractor then orders his material and goes ahead with the shop-work. All material and workmanship are carefully inspected by competent men, preferably selected by the engineer and paid by the purchaser. The mill and shop inspection can generally be done at least as well and more cheaply by a regular inspection firm and the field inspection either by the same firm or by a salaried inspector appointed by and acting under the supervision of the engineer. After the bridge is erected it is thoroughly cleaned and painted with the requisite number of coats of first-class paint carefully applied.

Unit Price Versus Lump Sum

The question arises as to whether work should be paid for on a unit price or lump-sum basis. If proper facilities are available for accurately determining the quantities, the unit price method is usually the best, then if minor changes are found desirable as the work progresses, nobody suffers any injustice. If the lump-sum plan is adopted, there is more certainty that the cost of the work will not exceed the appropriation, which is under many circumstances, a very important matter. In contracts for bridge masonry there is generally considerable uncertainty as to the depth to which the foundation must be carried. This can only be determined as the excavation progresses. The contract should be so drawn that no injustice is done if the depth of the foundation is much greater or less than shown on the plan. All plans for lump-sum work must, of course, show full details.

Appropriations and Engineering

It behooves the more intelligent citizens, as well as the engineering profession, who realize the necessity of a reasonable margin of safety, to convince the press and the general public of this necessity to the end that liberal appropriations may be made for the purpose of making proper inspections, repairs, alterations and reconstructions and also of the fact that much of this work is highly technical and must be placed in the hands of experts.

If the number and importance of the bridges involved is sufficient to justify it, competent men should be employed at adequate salaries to make inspections and repairs. Such men will make proper studies of traffic conditions and the peculiar dangers and conditions of each particular structure and act accordingly. They will take care of the most dangerous bridges first and, as funds are generally quite limited, will see that available funds are made to go as far as possible and that no work is undertaken for which there is not an adequate appropriation.

If the number of bridges is too small to justify the employment of a salaried engineer, one who is not connected with any concern engaged in constructing or furnishing material for bridges should be employed on a per diem basis.

It is the duty of officials in charge of public highways to maintain them in such condition that they are safe and convenient for all reasonable and lawful traffic which may come upon them; and the limit of loading on bridges of a State should be fixed by statute in order to determine what are reasonable and lawful loads. It being understood, always, that any private parties desiring to transport heavier loads on them than is provided for by statute, can do so by paying the extra cost of making the bridges of the desired strength.

EXISTING MACADAM BASE FOR BITUMINOUS PAVEMENTS

By George C. Warren, President Warren Brothers Company, 142 Berkeley St., Boston, Mass.

(Editor's Note—The following discussion by Mr. Warren was based on papers presented on this general subject at the recent annual convention of the American Society for Municipal Improvements by Mr. Julius Adler and Col. R. Keith Compton. Mr. Adler's paper is published in this issue).

While confessing to be one of those who from the first, and especially during the past ten years has broadly and persistently urged and successfully practiced to a very large extent the great economic conservation value of old macadam roads as a foundation for stable bituminous surfaces, I believe I am not one who has not appreciated and not expressed caution of its limitations.

First, Be Sure of the "Macadam"

Of course, the so-called "macadam" must be either real macadam of either stone or gravel and of substantial strength and depth or it must be reinforced with new stone added to and compressed into the old macadam. A small percentage of stone or gravel in a large percentage of clay or other weak material is not macadam. Nor is a road which some may call "macadam" (but which in reality is merely a veneer of indifferently spread stone on a weak sub-soil) a suitable foundation for any street pavement wearing surface without substantial reinforcement by the addition of new metal. On the other hand, in nearly all cases where any stone or gravel has been spread and compressed on the sub-grade, there is at least a great salvage value which should be conserved.

In City Streets

In city streets, especially those having street railroads, it is necessary, in some cases, to remove some of the old macadam to provide against a too shallow gutter at the curb or too high a pavement surface grade at the railroad track. In most city streets, however, none of these conditions arise if the engineer will as closely as practicable follow the original contour and will not provide an exposed face of curb higher than is necessary to take care of surface drainage. In some cases a few additional catch basins may be necessary to reduce the flow of surface water in the gutter, but they can be provided at only a fraction of the waste necessary to remove the old macadam either as a whole or in part.

On Country Roads

In country road construction almost universally the necessary slight raising of the elevation of the pavement surface is advantageous and not detrimental. In other words, the higher the road surface is above the surrounding country, the better the drainage and more successful the pavement, whatever its foundation or surface construction may be.

Rules of Procedure

A few rules may be laid down, to wit:

1. Never depend on surface appearance nor even on test excavations made a few weeks or months before construction to determine whether or not the old macadam will require renforcement.

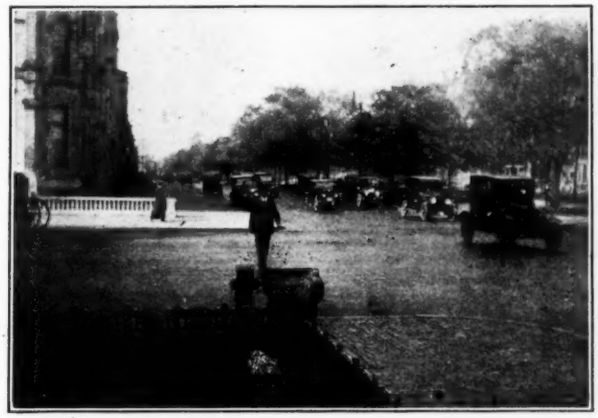
2. Always make test holes, or, better, test cuts across the street or road at intervals of say 100 ft. immediately in advance of construction and from those test observations come to an intelligent conclusion as to the necessity for a depth of new metal required to provide the necessary strength of base which will doubtless vary on different sections of the same project. The quantity of new metal, if any, cannot be definitely determined in advance. Consequently, such reinforcement should be paid for per ton or cu. yd. of new material actually used and bids taken on that basis. It is wasteful to attempt to determine and specify in advance of construction how many, if any, inches of new metal is necessary over the entire road. Even if test excavations are made in advance of preparation of plans and specifications preparatory to letting a contract, traffic may very materially change the condition before the construction period has arrived.

3. Do not disturb the old macadam for change of grade or contour or by scarifying unless absolutely necessary. Any such disturbance more or less reduces the strength and consequently the conservation value of the old macadam and sometimes actually removes practically all of it in the center of the road.

If the crown is excessively high, better correct by building up the quarters and outer edges with new metal than to remove solid road metal from the center unless there is a greater depth of solid macadam in the center than is necessary.

4. In every case where there is any road metal on the street, however thin or weak it may be, it is better to leave it in place and conserve it for "all it is worth" than to remove it, especially in these times of high cost of labor and materials.

5. If such test excavation as recommended in rule 1 develops 6 ins. or more of solid metal (whether gravel or crushed stone) in which the coarse particles (ranging from ¼ in. to 2 ins. or more in size) are more than one-half the total metal so that the finer particles merely fill the voids, then no treatment is necessary nor advisable except to regulate the grade, "knocking off" the high and filling up the low places by scarifying, picks in the roller, or hand picks, as may be most economical in each case, and then thoroughly roll the thus "prepared base."



COMMONWEALTH AVENUE, BOSTON, LOOKING WEST FROM DARTMOUTH STREET

Warrenite-Bitulithic Pavement Surfaced Over Old Macadam in 1916. Photo Taken October 5, 1920. Traffic 7 A. M. to 7 P. M. 13,718 Vehicles as Shown by Average of Two Day Traffic Records Taken Saturday, October 2, and Tuesday, October 5, 1920.

6. If such tests show that the fine particles predominate, or the depth is insufficient on the whole or any part of the macadam road or street, that condition does not justify excavation and wasting of the material, but just add to the old surface, after regulating its grade, whatever depth of new metal intelligent consideration of all the conditions indicates is best and safe. It will surely require much less labor and will be much less costly than to remove the old metal and supply an entirely new base.

7. If the drainage is poor, it should be corrected. A greater depth or more rigid type of base does not correct faulty drainage. On the other hand, faulty drainage can be corrected at much lower cost than by destroying the old macadam and furnishing new foundation.

Drainage All-Important

Before the A. S. M. I. and at other times and places, I have repeatedly made a statement to the effect that "from the days of John MacAdam down, the first thing practically every writer on road construction has said is 'drain,' but it is the one thing that most engineers fail to consider or intelligently practice in preparing plans." I

believe this engineering shortcoming is only somewhat less potent at this time than it was ten years ago. Specific reference to drainage is made in Col. Compton's paper. This failure to provide drainage is the prime cause for failures which bring out such statements as that of Mr. Adler in his paper, now under discussion, as follows:

> Macadam types were similarly damaged in some localities during the past winter and, in at least some of these places, there is a growing tendency to disregard the possible value of these roads and the investment in them.

This disaster during the past winter, or rather, spring, thaws was not at all confined to roads, the foundations of which were of "macadam types" nor to any special type or types of surface. In fact the trouble was universal throughout New England, New York, etc., in places where drainage had been ignored or was faulty. The past winter was unusually severe in those sections, including protracted cold, excessive snowfall, and sudden spring thaws. The accompanying illustration of a type of block pavement surface on Portland cement concrete base is sufficient to illustrate the point. No one who examined the condition would fairly charge the destruction to either the type of surface or base. *It was simply faulty drainage.*

A RESULT OF POOR DRAINAGE

Asphalt Block Pavement Laid on 6-in. Portland Cement Concrete Base. The Workmanship on this Contract Was of the Best in Every Respect. The Trouble is Due to Insufficient Drainage and Not to Type of Wearing Surface or Base. Note that the Road Bed is Several Inches Below the Adjoining Property—a Condition which in Itself Always Tends to Contribute to Drainage Trouble.

Note that, without curbing, the road surface is several inches below the abutting land—a condition which itself always invites drainage disaster, as it provides no outlet for surface drainage except to seep under the road. During that period (early spring of 1920) I had occasion to examine a road which had "exploded" for a length of about a mile. It was a rolling country and the middle of the damaged section was a sump, formed by long grades ascending in both directions. Of course this is a condition requiring most careful consideration of drainage, but none had been practiced and the consequent damage in one week's thaw in that one mile was about $20,000. Not only was no sub-surface drainage provided, but a telephone conduit had been put through the street without even installing lateral drains or "weep holes" for escape of water, which it should have been anticipated would likely accumulate in the conduit. For most of the distance the roadway was several feet above the abutting land, so that lateral drainage from the conduit would have been very simple and inexpensive. As a result of this oversight, during the thaw of last spring the telephone conduit became filled with water from sub-surface drainage and overflowed through the manholes.

It has been suggested that macadam base is applicable for block pavement. While confessing to no practical experience in this connection, I would advise against such practice until its sufficiency has been proved by several years' broad practical experience under varying conditions. My fear is that the irregularities of surface would prove disastrous. Surely the blocks could not be laid directly on the macadam, as is the practice in laying bituminous surfaces. If the blocks are laid on a cushion of Portland cement mortar over the macadam, the thin cushion would probably break up from traffic over the completed pavement. A sand cushion on the other hand would be more or less irregular in depth and probably cause the blocks to rock and settle unequally under traffic.

Stability of Bituminous Mixture

Attention should also be called to the importance of stability of bituminous mixture especially in connection with macadam bases. As an example of practical comparative experience—Commonwealth Avenue, from Arlington Street to Brookline Avenue, Boston, was surfaced in 1916 with Warrenite-Bitulithic laid over the old macadam without any new metal. This section of Commonwealth Avenue is the leading thoroughfare and carries the greatest volume of traffic in the city. Traffic records during twelve hours (7 A. M. to 7 P. M.) show the following:

Saturday, October 2, 1920.....	13,316 vehicles
Tuesday, October 5, 1920.....	14,120 vehicles
Average per day (12 hours).....	13,718 vehicles

No repairs in five years since laid and the present contour and surface are as perfect as could be. Two years later the section of Commonwealth Avenue to the Boston-Newton line, subjected to much less traffic, was improved by a fine aggregate asphaltic surface laid over the old macadam, and the surface is already quite badly undulated.

The specifications embodied in Col. Compton's paper suggest that after other preparation of the old macadam, a layer of crushed stone should be spread over and rolled into the old macadam " to form a coarse, grainy surface of fresh clean stone which will bond the bituminous paving material." Our quite extensive experience from the Altantic to the Pacific (Commonwealth Avenue above cited is one instance, and the three 12-mile approaches from Portland, Oregon, to Columbia River Highway another instance) brings the conclusion that such treatment is quite unnecessary and that the real test of requirement of new metal should be the one of depth and solidity of the old macadam as above outlined in some detail. Photographs of these two important prominent highways, proving the points under widely varying climatic conditions, are herewith reproduced.

PAVED HIGHWAYS FOR PRESENT-DAY TRAFFIC

By Arthur H. Blanchard, Professor of Highway Engineering and Highway Transport, University of Michigan, Ann Arbor, Mich.

This discussion of "Paved Highways for Present-Day Traffic" will be confined to the consideration of traffic on interstate and intrastate trunk highways and the roadway requirements which should be met in order to provide properly for traffic development.

Highway Transport Surveys

An investigation of the probable traffic development on any highway outside of a municipality should be based upon what has come to be commonly known as a highway transport survey, which includes a consideration of all classes of traffic which might use the highway, rural and urban transportation opportunities and competing carriers including railway and waterway facilities. What are the several methods of transportation included in the general term, highway transport? It is evident that highway transport includes all methods of transportation of passengers and commodities over highways.

Rural Motor Bus Routes

We have been familiar, for many years, with the utilization of highways for the transportation of passengers through the medium of horse-drawn vehicles and runabouts, touring cars and limousines. A development in this field with which the highway engineer must reckon is the installation of motor-bus routes on highways outside of municipalities. England has had an enormous development in this field during the past 15 years. In this country, such development had gained a certain headway prior to the war, as indicated by the successful operation of 125 rural motor-bus routes in 1914 in the State of New York. Motor-bus routes have rapidly developed for the transportation of passengers between urban districts which are not adequately served by steam and electric railways. Another development along this line is the utilization of the motor-bus for the transportation of children to consolidated rural schools. The State of Michigan is at the threshold of this development and should give it thorough consideration at once in order to provide adequate and high grade educational facilities for its rural population. To give some idea of the development of traffic in this field, it is well to call attention to the fact that approximately 2,000,000 children living in 65,000 old rural school districts throughout the United States are now being transported daily throughout the school year to 13,000 consolidated schools.

Types of Highway Transport Requiring Consideration

The methods of transportation of commodities are many and varied. Restricting the discussion to the methods used outside of municipalities, we have first what may be called intercity haulage, which includes all methods of highway transport used for transportation of commodities between municipalities. We then have short and long rural haulage which includes all highway transport methods which utilize highways outside of municipalities except inter-city haulage and highway transport operating on definite routes according to service schedules. In this field is included transport by companies whose business is exclusively long and short distance trucking and the traffic resulting from the transportation of commodities by men engaged in farming, by wholesale and retail stores of our municipalities, and by the transportation departments of our plants, factories, lumber camps, mines and other industries using natural resources. There are several other methods of highway transport which require consideration but only one more will be mentioned, namely, the rural motor express, which pertains to the transportation of commodities on prescribed routes and, generally, according to schedule, in the field of commerce between rural producers and a terminal city, village railway depot or waterway dock. By analyzing the development along each of these lines of highway transport, we arrive at an estimate of the vehicular traffic which will use a given trunk highway.

Traffic Investigations in Rhode Island

In most cases, provision must be made for a rapid increase in the volume and weight of traffic units. For example, the writer has recently received results of traffic investigations in the State of Rhode Island. On one trunk highway, the daily motor truck traffic increased 1,113 per cent. between August, 1913, and August, 1920, the numerical daily increase being from 47 motor trucks in 1913 to 570 in 1920. On another trunk highway, the increase in automobile traffic from 1915 to 1920 was 102 per cent. or an increase in number of vehicles from 1,980 in 1915 to 4,008 in 1920, and an increase in this period of 659 per cent in the number of motor trucks, as in 1915, the daily average was 79 and in 1920, it was 600. These increases are due solely to the development of highway transport and not because the trunk highways cited were unimproved in 1913 and 1915, respectively. In considering these increases, it should be borne in mind that Rhode Island has had a large percentage of its trunk mileage constructed for many years as it started its highway development program in 1903 with a law which provided only for a system of state trunk highways to be constructed and maintained by and at the expense of the state.

Factors in the Problem of Design

The problem of the design of a highway from the standpoint of traffic resolves itself into a determination on the probable amount and character of vehicular traffic during a future period, the design of the grades, curves, and width of the road way so that it will be efficiently serviceable for the traffic which it is to carry, the determination of the amount and character of external forces to which the different parts of the highway are subjected and finally the design of the bridges, drainage systems, foundations and roadways so that they will have sufficient internal strength to resist the external forces during a reasonable period of time.

Influence of Truck Traffic on Design

The forces, due to motor truck traffic, which should be given consideration in the design of a roadway wearing course and its substructures are the direct load causing compression, impact forces, shearing forces of the driving wheels, and the resultant forces between the subgrade and the pavement foundation. Necessarily these forces are functions of the volume, weight, speed and character of the vehicles using the highway. These factors are determined as a result of information furnished by highway transport surveys and legislative regulations cover-

ing these factors. The best indication which we have of the probable normal maximum weights of vehicles to which highways will be subjected in the immediate future is the recommendation of a committee of the National Highway Traffic Association which was adopted at the 1919 Convention of the American Road Builders' Association and which was later incorporated in the Proposed Uniform Vehicle Law, which is supported by several national organizations. The above recommendation pertaining to motor trucks allows a load per linear inch of width of tire of 800 lbs. and a maximum gross load on four wheels of 28,000 lbs. These limitations, which have been embodied in the laws of several states, allow the use of motor trucks having a capacity of 7½ tons. In this connection, it should be noted that the Trailer Manufacturers' Association of America has advocated legislation limiting the weight on four wheels of a trailer, including vehicle, body and load, to 28,000 lbs. These recommendations give us a definite starting point for the design of pavements and their substructures. Although those who have given careful consideration to the probable development of highway transport believe that the economic and efficient development of this form of transportation will not necessitate, for many years, the utilization of motor trucks having a greater capacity than 7½ tons, nevertheless it is admitted that it may be desirable in isolated cases to transport over highways loads on four wheels in excess of the limit prescribed. The transportation of such weights, however, should be provided for by special legislation rather than be accepted as the fundamental basis for design. This matter has been properly handled in a regulation which has been advocated for inclusion in state status by the Trailer Manufacturers' Association of America. This section reads as follows: "Authority to be given to state, county, city and township authorities to issue special permits for the operation of vehicles exceeding the foregoing gross weights, weights per axle and weight per inch of tire over highways under their jurisdiction, provided the highways and bridges to be used are designated and operators of the vehicles for which permits are issued are made responsible for any damage that may be done to the highways and bridges by reason of such operation." The recent transportaion of a load of 100,000 lbs. on a single trailer would come within this provision.

Width of Pavements for Trunk Highways Carrying Heavy Truck Traffic

This discussion will be limited to a consideration of pavements suitable for interstate and intrastate trunk highways which will be subjected to an intensive motor truck traffic. The width of the pavement should first be given consideration. Roadways economically designed must provide for carrying the traffic on the paved roadway surface and not rely upon shoulders to carry a part of the traffic or serve as turnouts. It has been demonstrated that the latter practice is neither economical from the standpoint of the maintenance of pavements and shoulders nor is it efficient or safe from the standpoint of the traffic using the highway. In other words, we must provide for a minimum of two lines of commercial traffic and it is obvious that an operator of a heavy motor truck will insist upon allowing a certain amount of leeway between the outside wheels of the truck and the edge of the pavement since many operators have had unfortunate experiences with motor trucks being stalled in soft shoulders or ditched. Considering the factors of widths and speeds of passenger cars and motor trucks utilizing trunk highways and that the laws of many states permit a maximum width of 8 ft. for motor trucks, taken in conjunction with the rapid increase in the volume of traffic on trunk highways, the conclusion is reached that 20 ft., for the width of the pavement surface of a trunk highway, should be considered the minimum. There are highways where the normal traffic requires provision for two lines of vehicles and the abnormal traffic particularly on holidays, Saturday afternoons and Sundays will render the adoption of 24 to 26 ft. justifiable. This is due primarily to the fact that provision should be made for vehicles standing at the side of the road while temporarily requiring repairs. While traveling on a highway in the vicinity of Detroit on a Sunday during July, 18 vehicles parked at the side of the roadway, and under repair, were passed in 15 minutes on a 5 mile section. If the transport survey indicated that the normal amount of traffic will require provision for more than two lines of vehicles, a greater width than 20 ft. must be adopted, the additional width depending upon the character of the traffic. It does not require much imagination to reach the conclusion that many interurban highways will be subjected, during the next decade, to traffic which will necessitate roadways sufficiently wide to accommodate at least four lines of vehicles, which would mean a width of 38 to 48 ft.

Materials of Construction

For the classes of trunk highways under consideration, the roadway wearing course should be composed of a brick, cement-concrete (plain or reinforced), bituminous concrete, sheet asphalt, wood block, or a stone block payment supported by a reinforced concrete, plain cement-concrete, bituminous concrete or heavy stone foundation. The selection of the particular type will depend upon many local economic factors and the results of the transport survey.

One Motor Vehicle to Every Fourteen People in U. S.

If these recommendations relative to the requirements of present-day traffic on trunk highways are not considered conservative, contemplate the following facts pertaining to the increase in the use of motor vehicles during a period of five years. In 1914, the total registration of motor vehicles in the United States was 1,711,339, while in 1919, it was 7,558,848. This means 1 motor vehicle to every 14 persons throughout the Union. In Michigan, the 1919 records show that there was 1 motor vehicle to every 10 persons. During this same period of 5 years, the number of motor trucks in use increased from about 136,000 to 750,000. A conservative estimate indicates that the registration of motor trucks in 1920 will exceed 1,000,000.

The highways outside of our municipalities have had a changeable status during the past 30 years and the reasons advanced for their improvement have been many and varied, but mostly sound. Fortunately, there has been rapidly developing throughout the land a conviction that highways are merely a means to an end and that that end is the economic and efficient transportation of passengers and commodities. It has become self-evident that unimproved and improperly built highways consti-

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tute a positive barrier to the development of economic highway transport. In order that highway transport should take its proper place in our transportation system, the following fundamental guiding principle must be accepted generally: Highways should be designed, constructed, and maintained so as to enable them to carry efficiently the motor vehicles required for the rapid development and economic utilization of highway transport.

The foregoing paper by Prof. Blanchard was presented at the annual convention of the Michigan Good Roads Association held at Lansing on Sept. 2, 1920.

ANNUAL CONVENTION OF THE AMERICAN SOCIETY FOR MUNICIPAL IMPROVEMENTS

The 1920 annual convention of The American Society for Municipal Improvements, which was held in St. Louis Oct. 12-15, was very generally considered by those in attendance as the most successful convention the Society has held in recent years. There was an exceptionally interesting and full program of papers presented and the response by the delegates to the papers, in the form of discussions, was spontaneous and on a high professional plane.

The committee reports on recommended standard specifications were a feature of the convention this year as always. The committees deserve much credit for the hard work done in standardizing specifications covering the various phases of municipal engineering work.

There were several round table discussions, during the luncheon periods, at which matters of interest to the members were presented for consideration and acted upon. Thus the schedule of salaries for engineers in municipal service, as adopted by The American Association of Engineers, was presented in one of these round table discussions and later taken up on the floor of the convention. After presentation and discussion on the floor of the convention this schedule of salaries was approved by unanimous vote.

During the war this Society, perhaps, suffered somewhat from the prevailing depression in municipal engineering activity, but the very successful convention of this year is thought to reflect the very greatly improved status of municipal engineering affairs. It is confidently believed by all interested in the welfare of the Society that during the coming years it will attain a period of influence and artistic success in its field unsurpassed by any other professional organization in the country. The editor begs leave to invite the support of all interested in the making of public improvements, for this Society, which has a distinct field of usefulness. It is hoped that workers in this field will feel that they should support the Society by membership and, when possible, by attending its meetings.

The convention arrangements in St. Louis merit specific comment and commendation. The delegates were unanimous in their praise of the results of the great work done by the St. Louis committee in charge of all the convention arrangements and details. We believe that all those interested in municipal improvements and, therefore, in the vigorous growth and development of this particular Society are indebted to the St. Louis men who gave so much of their time to making this recent convention a decided success.

Several of the leading papers presented at the convention are published in this issue of "Municipal and County Engineering." That we are giving more space in this number to the papers presented at this convention, than

VIEW IN EXHIBIT ROOM AT ANNUAL CONVENTION OF THE AMERICAN SOCIETY FOR MUNICIPAL IMPROVEMENTS, ST. LOUIS, MO., OCTOBER 12-15, 1920.

has ever been devoted before in this journal to the proceedings of any convention, is the best evidence of the impression made upon the editor as to the merit of typical leading papers on the 1920 program.

Col. R. Keith Compton, Chairman and Chief Engineer of the Paving Commission of the city of Baltimore, was elected president for the coming year, and Charles Carroll Brown, Dean of the College of Applied Sciences at Valparaiso University, was re-elected Secretary. The 1921 convention will be held in Baltimore.

PROPOSED LEGISLATION AFFECTING COUNTY ENGINEERS

The temporary legislative committee of the Oklahoma Highway Engineers has recommended and the highway engineers have adopted the following proposed legislation:

The county engineer shall be appointed by the board of county commissioners. He shall have charge of and be superintendent of all maintenance and construction on the public highways of the county, and of one county only. The minimum salary to be paid in counties with a valuation of ten million dollars or less shall be $2,100 per annum. Where the valuation is from ten to twenty million the salary shall be a minimum of $3,000 per annum; twenty to thirty million, $3,600 per annum; thirty to fifty million, $4,200 per annum; fifty million or over, $4,800 per annum.

The law governing the destruction of roads to be made more clear and more stringent. The load per bearing inch and maximum of any wheel to be limited.

All construction work to be performed under the direction of the county engineer to be approved by the state highway department before construction is authorized by the county commissioner.

WATER WORKS SECTION

MAKING USE OF UNUSUAL GEOLOGICAL FORMATION PERMITS CARRYING OUT NEWARK, N. Y., WATER SUPPLY PLAN

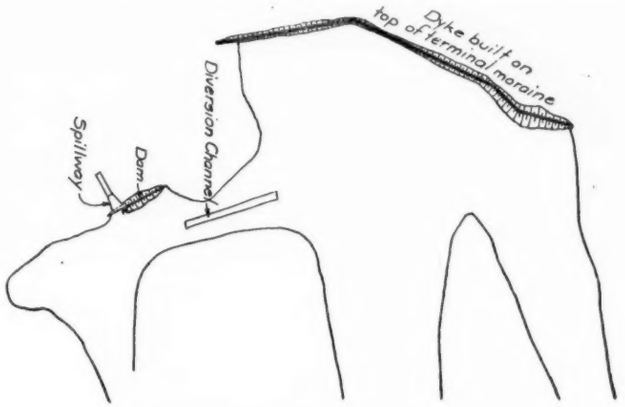
By James P. Wells, Hydraulic Engineer, Cutler Bldg., Rochester, N. Y.

Previous to the construction of its gravity water supply system, Newark, N. Y. had suffered for some time from a lack of water. It was suggested by the writer that it would be possible to get a gravity supply by going some eight miles to the south. Though the city commissioners had been searching for some ten years for a new water supply and the gravity plant had never been thought feasible, the writer was commissioned to make an investigation and report with estimates of cost of bringing water to Newark by gravity.

There is probably no other locality in the northern part of the United States which shows so clearly the effect of glaciation as the district in which Newark lies. A glance at the topographic maps of this region will show hundreds of drumlins running north and south. The greater number of the small streams flow to the north in between the drumlins.

Topographical and Geological Conditions

An investigation was made of several streams and it was found that a good supply of water could be obtained from one with a drainage area of about six square miles providing it were possible to build a storage reservoir large enough to store about 225,000,000 gals. A survey was made and the survey indicated that it would not be feasible to construct a reservoir with a capacity greater than 75,000,000 gals., and that even with a reservoir of this capacity it would be necessary to construct a small dike on the east side of the reservoir to prevent the water from going over into an adjacent valley. The writer made an examination of this adjoining valley and found there was a terminal moraine cutting across the front of it and that while this valley had no tributary drainage area to speak of, that a dike could be constructed at a relatively low cost on top of this terminal moraine and the basin thus created would provide additional storage. The water would simply have to be diverted into the basin from the main stream and the water in both valleys would be kept at the same level, and by this means the capacity could be increased to 225,000,000 gals. In order to divert the water into the adjoining valley and have sufficient depth at the divide so that both portions of the reservoir could be drawn upon, it was only necessary to excavate a channel for a short distance from a maximum depth of 10 ft. The writer submitted his report with estimates of cost and an appropriation was voted in March, 1919, to carry out the proposed work.



MAP OF IMPOUNDING WORKS OF GRAVITY WATER SUPPLY FOR NEWARK, NEW YORK.

Runoff Estimated

Case Creek, the stream upon which the dam has been constructed, has a drainage area slightly in excess of six square miles. From the records of adjacent streams it was estimated that in an extreme low year the average daily runoff for the entire year would be at least 3½ million gallons per day. The runoff during the early part of the year is sufficient to keep the reservoir filled until the latter part of May or June. There is occasionally a year when there is very little runoff for as much as five or six months of the year beginning with July, and for this reason it was considered advisable to build a reservoir large enough to supply the desired quantity of water for six months of the year even if practically no

CORE-WALL OF DIVERSION DAM FOR NEWARK, NEW YORK, GRAVITY WATER SUPPLY SYSTEM.

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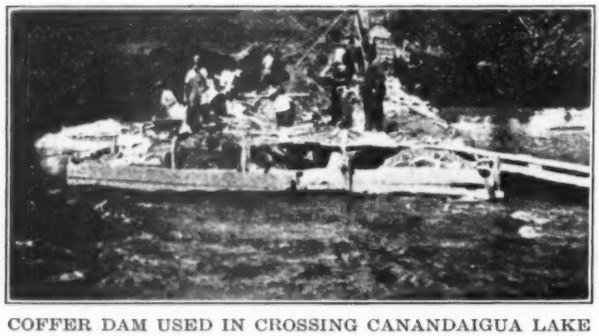
water came into the reservoir. The present supply is about 1 million gals. a day and to make sure of this supply being always available a reservoir of 225,000,000 gals. capacity was constructed. This gives a liberal allowance for seepage and evaporation.

Earthen Dam and Dikes

Test pits on the site of the work and other conditions indicated that an earthen dam with a concrete core-wall and dikes of the same nature would be the most economical type of construction. The foundation for the dam on the main stream was for the most part clay underlaid with shale rock, though at one end was a bank of gravel. As has been mentioned above, in the case of the adjoining valley, the dike had to be built on the terminal moraine and this was composed of gravel. As this dike would have to be of considerable length, nearly one-half mile, it was evident that there would be considerable seepage underneath the dike when the reservoir was first filled with water. The dike was built with a concrete core for the greater part of its length, but in the lower portions no core was used. The core extends into the gravel about 8 ft. As was expected, when the reservoir filled there was considerable seepage underneath the core-wall. This has gradually decreased, and judging from experience with other reservoirs should stop entirely within a year or two. The stream entering the reservoir carries considerable silt in flood times and as this silt settles in the reservoir the seepage is taken up.

The material for the earth fill was excavated by steam shovels loading into dump wagons, and for the low sections of the dike by scrapers. The material was put down in layers. The embankment has a top width of 10 ft. The upstream slopes are 2½ to 1 and the down stream slopes 2 to 1. Rip rap 1 ft. thick was placed on the upstream side of the reservoir. The spillway was built in the dam on the main stream. It has a width of 80 ft. and its crest is 5 ft. below the top of the earth fill. The entire spillway, including the over-flow portion, wing walls and the paving of the spillway channel rest upon shale rock.



COFFER DAM USED IN CROSSING CANANDAIGUA LAKE OUTLET NEWARK GRAVITY WATER SUPPLY.

Concrete

The core-wall of the dam is built of Class "C" concrete in proportions 1, 3 and 6. As this core-wall serves the purpose of preventing water from going through the dam the specifications permitted the use of local gravel. While this material was not of the best quality, it made a tight wall and the cost of the concrete was much less than it would have been if it had been necessary to bring in the gravel. The contract price for the concrete in the core-wall was $7 per cu. yd. In the construction of all exposed concrete, imported gravel was used of the very best quality. The over-flow portion of the spillway and the side walls were built of Class "B" concrete, 1, 2½ and 5. The paving of the spillway channel was built of Class "A" concrete proportioned 1, 2 and 4.

Filtration Plant

The drainage area of the storage reservoir is practically all farm land and there are a number of dwellings and other buildings on the watershed. The main stream comes into the reservoir about a mile away from the intake, so that there is an excellent opportunity for the water to improve greatly in its condition before reaching the intake. It was considered necessary, however, to construct a small filtration plant before turning the water into the mains. This filter plant is of the rapid sand type. The water is first aerated and from the aerator flows through a Venturi Tube into the sedimentation basin. By means of the Venturi Tube the amount of chemical, sulphate of aluminum, is proportioned to the amount of water used. From the sedimentation basin the water passes on to two filter beds, each of which have a capacity of 500,000 gals. per day. The sub-structure of the filtration plant is of reinforced concrete and the superstructure of brick with an outer layer of tapestry.

CHANNEL DIVERTING WATER FROM MAIN STREAM OVER INTO ADJOINING VALLEY, NEWARK, N. Y., WATER SUPPLY WORKS.

Pipe Line

Leading from the filtration plant is a 14-in. cast iron pipe. Its total length is about eight miles. For the greater part of its length it was found possible to lay the pipe underneath the highway, and by that means to save the cost of a private right-of-way. A considerable amount of rock was found in the line and the greater part of this had to be drilled and blasted. Two streams, both of a width of about 200 ft., had to be crossed. At these crossings a trench was excavated in the bed of the stream 3 ft. wide and 3 ft. deep. A few inches of concrete were laid in the trench, the pipe placed on top of it and thoroughly embedded and the trench filled with concrete so that the concrete was flush with the bed of the stream.

Work Cost Less Than Estimate

The writer estimated that the entire undertaking would cost $330,000, including lands purchased and rights-of-way. As a matter of fact the work has cost only $300,000, $30,000 less than the estimate.

Personnel

The plans and specifications were prepared and the work done under the supervision of the writer with offices at 249 Cutler Building, Rochester, N. Y., and 103 Park Avenue, New York City. E. P. Strowger was resident engineer in charge of construction. The Norwood Engineering Company, of Florence, Mass., were the contractors for the filtration plant, the United States Cast Iron Pipe and Foundry Company, of Burlington, N. J., for the pipe, James F. Leary & Co., for laying the pipe, and Lupfer & Remick, of Buffalo, were the contractors for the dam.

REMOVING IRON FROM PUBLIC WATER SUPPLY AT SHELBY, OHIO

By Philip Burgess, of Burgess & Niple, Consulting Engineers, 141 East Broad St., Columbus, Ohio

It is a well recognized fact that the presence of a considerable quantity of iron in a public water supply is objectionable, but unfortunately there are comparatively few instances where such public water supplies have been developed and improved by purification, so that it is believed that the experiences of The Shelby Water Company, at Shelby, Ohio, in the development of a ground water supply containing considerable quantities of iron will be of general interest.

Historical

The water works at Shelby were installed by the local water company in 1897, and the supply was obtained without treatment from drilled wells 40 to 60 feet deep, contained in a 10-acre tract bordering on Black Fork Creek and situated about one mile above the center of the town. Preliminary tests were made of the quality of the supply and the report of the analyst under date of October, 1896, contained the following:

> The water is very high in free ammonia, rather high in albuminoid ammonia, pretty well up on oxygen required. The water is a suspicious water. I should suspect it of containing animal sewage well fermented, but not exposed to oxidation. The practical absence of nitric acid may mean, however, that the free ammonia is largely due to nitrates reduced to ammonia by working through soil and rock containing reducing agents, possibly sulphide. This is theory, however, and a full investigation of these features will be necessary before this water could be considered safe, as the analysis, on the face of it condemns it. This latter theory would be supported by the large amounts of sulphates (permanent hardness).

The analyst's statement indicating that the water was "suspicious" is of interest and indicates the general lack of information relative to the significance of organic matter in ground water supplies. Bacterial analyses have always indiciated that the water supply at Shelby is practicaly sterile so that the high organic matter contained in the water is of no significance as regards its sanitary qualities. It merely indicates that the water takes up organic matter from the alluvial deposits which are swampy and contain considerable deposits of a decayed vegetation probably of pre-historic times.

First Iron Removal Devices

Use of the water supply at Shelby soon indicated that it was generally very unsatisfactory for domestic purposes on account of its high iron content and some 8 years later, in 1905, the company installed devices to remove the iron. These included aeration through perforated, horizontal, steel baffles in the top of the stand-pipe, sedimentation in the stand-pipe, and finally, filtration through two horizontal, steel pressure filters 8 ft. in diameter, by 24 ft. long. The filters contained 18 ins. of crushed quartz, having an effective size of 0.75 mm. The water was improved by these devices and the iron reduced from approximately 7 parts per million to about 0.6 to 0.8 parts per million.

While associated with the Ohio State Department of Health, the writer made an examination of the plant of the company in 1909 and numerous chemical and bacterial tests of the raw and treated waters were made at the plant.

At that time the total consumption of water was from 250,000 to 300,000 gals. daily. The iron was reduced to a little less than 1 part per million and the consumers were generally satisfied with the quality of the supply. Subsequently the water consumption at Shelby has increased until, during the past year, the consumption has been about 700,000 gals. daily, or double that during the year 1909, with the result that the removal of iron by the purification devices available was not at all satisfactory. The writer was retained by the company to design a new iron removal plant and subsequently his firm entered into a contract to construct this plant from the design furnished.

Description of New Iron Removal Plant

The general features or principles adopted in the new plant were similar to those in the old and comprise aeration, sedimentation, and filtration. The supply is the same as that originally acquired but the old drilled wells have been abandoned by the company and have been replaced by two dug wells, approximately 45 ft. deep. The new plant was designed for a normal capacity of 1,000,000 gals. daily. The aerator tower was based upon a normal capacity of 17 gals. per sq. ft. per minute. The aerated water is retained in the sedimentation or reaction basin for a period of one hour. The filters have a normal capacity of 100,000,000 gals. per acre daily. The clear well holds 250,000 gals. of treated water, equivalent to 6 hours' storage. The filters are covered with a substantial brick superstructure. All of the basins and filters are of reinforced concrete.

During operation of the new plant, water is pumped by electrically operated centrifugal pumps from either of the wells and is discharged at the top of the aerator through which it flows by gravity into the reaction tank, thence on to and through the filters into the clear well from which it is pumped by electrically operated centrifugal pumps under about 60 lbs. pressure, into the distribution system or stand-pipe. The latter is 16 ft. in diameter, 130 ft. high, and holds 196,000 gals.

Aerator

The aerator comprises 3 horizontal trays containing crushed coke. The trays are 12 ins. deep with 12-in. openings between trays. The bottoms are covered by wire screens containing 3½ meshes per inch composed of iron wire 0.105 in. in diameter. The coke layers are 12 ins. thick and are comprised of particles ranging in size from ½-in. to 3-ins. diameter. The trays are each 4.5 ft.

by 9 ft. in section with a total area of 40.5 sq. ft. The nominal rate of flow through the coke is 17.3 gals. per sq. ft. per minute. The aerator is located over the inlet end of the basin and water is distributed over the top tray by two lines of perforated 8-in. cast iron pipe. The centers of these pipes are 8 ft., 8 ins. above high water level in the basin.

Reaction Tank and Filters

The basin or reaction tank is uncovered and is 14 ft. by 43 ft. by 10.5 ft. deep. It holds 47,300 gals. so that the period of retention in the tank is 66 minutes.

The filters are 2 in number and are open gravity sand filters, each containing 240 sq. ft. The total filter area is 0.011 acre.

The strainer systems comprise 10 in. cast iron main collectors and 1½ in. extra heavy galvanized iron laterals 6 ins. apart. The laterals are perforated with ¼-in. round holes spaced in two rows, six holes per lineal foot of pipe.

Over the strainer system is the filter gravel placed to total depth of 12 ins. and comprised of particles ranging from 1/12 in. to 2 ins. in diameter.

Above the gravel is placed 2 ft. of filter sand with an effective size of 0.49 mm. and uniformity coefficient of 1.75. Considerable thought was given to the selection of sand of the proper size and experience indicates that the sand used is entirely satisfactory.

The filters are washed through a 10-in. cast iron pipe connection from the stand-pipe and the rate of application of the wash water is from 20 to 24 ins. rise per minute. The tops of the wash water troughs are 24 ins. above the filter sand.

An unusual feature of the design is that high water in the clear well is 3 ft. above the bottom of the filters so that the total effective depth available for filtration is 3 ft., when the clear well is full. No controllers are provided in the effluent pipes on the filters. It is obvious that as the clear well becomes full, water backs up on the filters tending to reduce the head available for filtration and consequently to reduce the rate of filtration. This feature permitted considerable saving in the construction and operation of the plant. Moreover, the total head available for filtration has proven to be ample, notwithstanding the fact that it is customary to keep the clear well full.

Operation of Plant

The new iron removal plant at Shelby was first placed in operation on March 19, 1920, and has continued in successful operation since that time. It is of interest to note that the elimination of iron from the supply has been entirely satisfactory from the beginning of operation.

The actual results accomplished by the plant have been determined from time to time by analyses of samples collected by the superintendent of the company and shipped to the laboratory of the State Department of Health, at Columbus.

In general the iron content of the well water is high, ranging from about 5 to 8 parts per million in well No. 2 and 16 parts in well No. 1.

Analyses of the samples obtained from the supply to the filters indicate but slight change in the chemical and physical qualities of the water as effected by aeration. Later tests made by Mr. Roberts, Assistant Engineer of the State Department of Health, indicate that the dissolved oxygen content of the raw water was increased by aeration from 0 to 64 per cent. saturation and that the free carbonic acid is decreased by aeration from 43 to 16 parts.

Analyses of the total iron content are of especial interest and indicate that the filtered water at times contains only a trace of iron in the samples. The highest iron content shown at the plant is 0.3 part per million and from the mains in March, was 0.4 part per million. The increase of iron in the main as compared with that in the filter effluents was caused by the former deposits in the mains. It will be of interest to see how long these deposits continue.

In general the operation of the plant has been entirely satisfactory and the filtered water supply has been always clear and free from suspended iron.

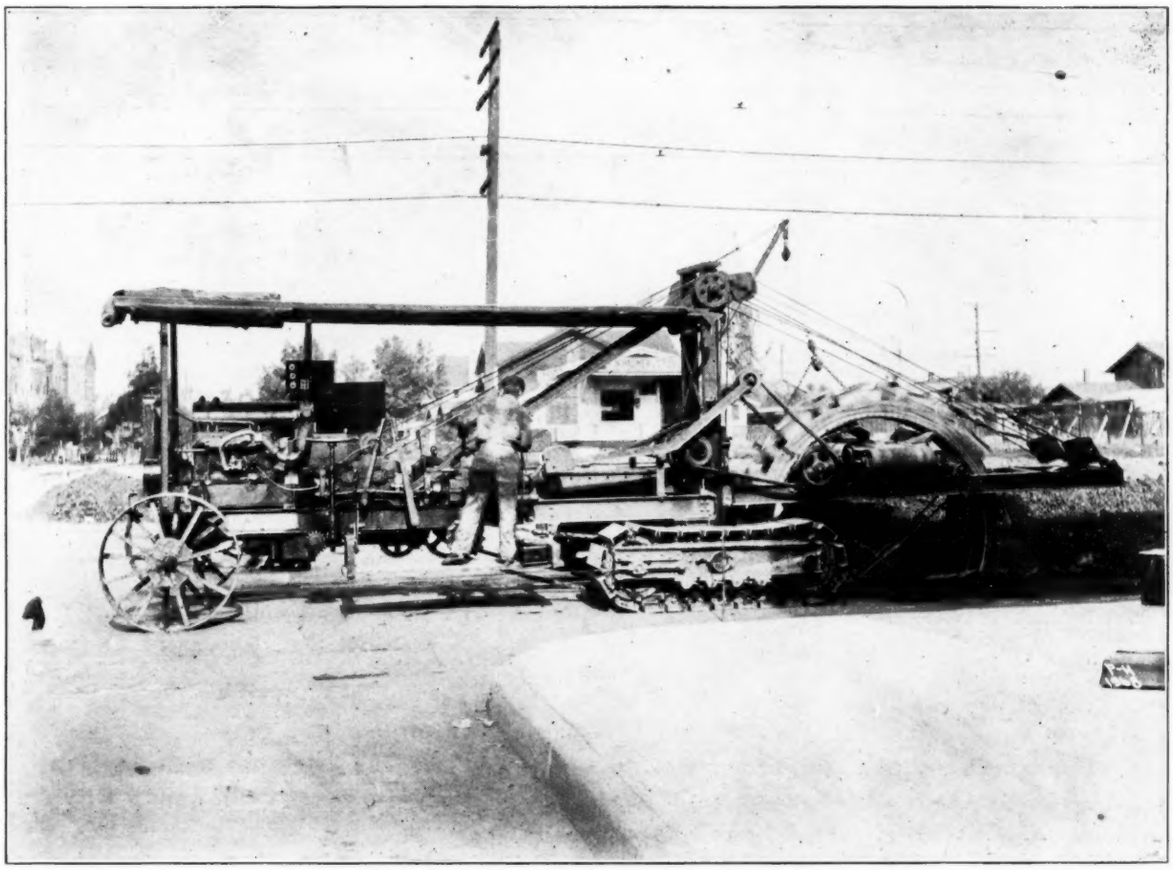
Experience indicates that the coke in the aerator tends to become coated with deposits of iron so that it is necessary to wash it every three or four weeks. This is done by washing the coke in place with a hose. But little sedimentation of iron occurs in the reaction tank, which is cleaned only once or twice yearly, and even at such times contains but a few inches of deposited precipitate. The filters are washed once daily at the rate of a little less than 24 ins. rise per minute and generally for a period of 4 or 5 minutes. The total quantity of wash water used is only about 4 per cent. of the quantity of water filtered so that in this respect, the operation of the plant compares favorably with that of similar rapid sand filter plants provided to improve surface water supplies.

The contract under which the writer's firm constructed the clear well and filters included all excavation and concrete structures, except the reaction tank which was built by the company; also the pipe lines except outside cast iron pipe lines. It did not include the brick superstructure nor back filling and grading around the clear well and filter house. The total contract price for the above was $16,500. Mr. Bricker, president of the company, has advised the writer that the superstructure cost about $1,500 and the aerator and reaction tank about $3,000 additional. It will probably cost about $800 to complete embankments and grading around the new plant so that the total cost of the new plant was about $23,000.

The Plant a Success in Every Way

In conclusion it should be noted that the recent experience of the company in providing a new iron removal plant has been entirely satisfactory and in fact, has proven beneficial in a number of ways. The satisfaction to the officials of the company in providing a clear water supply free from objectionable features, and to the consumers who are enjoying the new supply is very pronounced. Moreover, the new plant has resulted in a marked increase in quantities of water sold, thereby increasing the revenues of the company due in part to the more abundant use of water by former consumers and in part to new consumers who have been attached to the property since the new plant is in operation. Mr. Bricker has advised the writer that, during the past five months, the company has acquired more new consumers than they experienced during all the preceding five years.

Another feature of operation brought about by the



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new plant is that it is now very much easier to maintain service lines and meters than was formerly possible. With the use of raw water there were many instances where service lines became clogged with the deposits of iron thereby resulting in a loss of considerable sale of water and a considerable increase in expense entailed for maintenance of service lines. Similarly the iron contained in the water supply formed deposits on the meters eventually with the result that there was a general reduction in the quantity of water sold, not always apparent to the officers of the company. There is no question but what the sale of water and revenues received therefrom were materially reduced by the above features, which are now eliminated by the operation of the new iron removal plant. In general the relations between the officials of the company and the consumers are much more satisfactory, a condition which has resulted in increased income and benefits to the company and increased enjoyment and use of the public water supply to the consumers. The benefits derived from the new plant have more than compensated the company for the expense entailed by its construction and operation.

The above matter is the major portion of a paper by Mr. Burgess as presented at the 1920 meeting of the Central States Section of the American Water Works Association.

METHOD OF GRADING CITIES ON FIRE SERVICE EMPLOYED BY NATIONAL BOARD OF FIRE UNDERWRITERS

By Clarence Goldsmith, Assistant Chief Engineer, The National Board of Fire Underwriters, 234 S. La Salle St., Chicago, Ill.

Before considering the "Standard Schedule for Grading Cities and Towns of the United States with Reference to their Fire Defenses and Physcial Conditions," as prepared by the National Board of Fire Underwriters, it may be well to answer the question "What is the National Board of Fire Underwriters?" said Mr. Goldsmith in addressing the recent annual meeting of the Indiana Sanitary and Water Supply Association.

What is the National Board of Fire Underwriters

At the outset a little elimination will aid in reaching an understanding:

The National Board of Fire Underwriters is not a "fire insurance trust." It is not a corporation. It is not in any respect a money-making concern. It has no legislative powers over the business. It has no jurisdiction over companies or agents. It has had no rate-making functions since April, 1876, nor any jurisdiction over rates and premiums. It has had nothing to do with commissions or compensation of agents since July, 1886.

The National Board is an educational, engineering, statistical, and public service organization maintained by the stock fire insurance companies, and its membership includes nearly all of the important companies in this class. Theoretically, the service that it renders is to its membership, but practically, it has become to all intents and purposes a public service institution in most of its activities. This is due to the fact that for more than a generation, efforts in the direction of fire prevention have assumed a larger and larger part in the work of the Board, and fire prevention is essentially a public matter. Its work is carried on through the following committee: Actuarial Bureau, Adjustments, Clauses and Forms, Construction of Buildings, Finance, Fire Prevention and Engineering Standard, Incendiarism and Arson, Laws Membership, Public Relations, Statistics and Origin of Fires, Uniform Accounting, and Loss Information Service.

While a committee on Fire Prevention had existed since 1892, its present work is the direct outgrowth of the Baltimore Conflagration in 1904, when it was brought home to the fire insurance companies with special force that the increasing congestion of values in cities, where they could be affected by great conflagrations, represented a serious menace both to the public and to the fire insurance business. The crowding of populations into city limits in itself produced a fire hazard which called for expert study and systematic measures for fire protection and prevention. The Committee on Fire Prevention and Engineering Standards handles the engineering work for the Board.

Standard Schedule for Grading Cities

A natural development of the study of water supplies, fire departments, fire alarm systems and structural conditions has been the preparation of a Standard Schedule for Grading Cities and Towns with Reference to their Facilities for Fire Protection. The first step in the preparation of this schedule was the establishment of standards covering the different items entering into the various features of fire protection and prevention. The classification of any given city is determined by the application of points of deficiency depending upon the extent of variance from these standards, which were formulated from a study of conditions in more than 500 cities. The total maximum points of deficiency amount to 5,000 and the plan of having ten classes of cities or towns has been accepted.

The system has been adopted by insurance organizations having rating jurisdiction in the greater number of states and the application of the schedule is being actively pursued by these organizations and by the National Board in the larger cities. The results of the application of the schedule in respect to the fire protection improvements secured and the records of saving resulting therefrom have been very encouraging. The Standard Grading Schedule has been found to create a spirit of good will and cooperation on the part of city officials and civic organizations, and is believed practically to eliminate discrimination in city or town classification.

In the formulation of the standards for the different items not only the data collected by the committee in connection with its inspection work, but the standards commonly accepted by municipal and consulting engineers, when such had been established, were considered. These standards once established, apply in all cases, there being no separate standard for a small town and another for a large city. The fire defenses of a city are considered under the following main subjects: Water Supply, Fire Department, Fire Alarm, Police, Building Laws, Hazards, including those of lighting, heating, explosives or inflammables, and Structural Conditions.

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these several subjects. When the individual city is graded an additional deficiency is applied when the climatic conditions, such as winds, snowfalls, cold weather and hot, dry weather, vary from the normal conditions throughout the country, and further provision is made for making an additional charge when there is a material divergence in the classes of the fire department and water supply. It is manifest that where protection is furnished by a most excellent water supply and the fire department is seriously weak in men or equipment, that the full value of the water supply cannot be utilized in fighting fire, neither could a fully manned and well-equipped fire department operate at its maximum efficiency if the water supply was seriously deficient. The relative values of points assigned to the several subjects were carefully weighed and considered. The number of points assigned to water supply when the city is on the engine stream basis is 1,700, and when on a hydrant hose stream basis 2,000 points; to fire department when the city is on the engine stream basis 1,500, and when on a hydrant hose stream basis 1,200 points; fire alarm, 550; police, 50; building laws, 200; hazards, 300, and structural conditions, 700 points.

Water Supply Section Has 32 Items

The 43 items in the Water Supply section of the schedule will be discussed in detail. These items are divided into three main classes, dealing with organization, adequacy and reliability, respectively.

Personnel

In order that a system may be efficiently operated the tenure of office of all employes should be secure. In municipally owned works this can best be assured by civil service rules, properly administered. Civil service does not secure ideal conditions, but in general is found to be the most satisfactory means of precluding political influence; the object to be obtained is long tenure of office and an efficient organization.

The chief executive, who may be called either the superintendent or chief engineer, should be competent and qualified by experience, preferably supplemented by education to fill the office efficiently. A competent executive, although without extensive experience in waterworks engineering, when associated with experienced engineers, frequently secures satisfactory results, particularly in the direction of the larger systems.

Records

In order to operate efficiently and design economically for future growth, it is necessary to have accurate and complete records; these should include a skeleton plan, showing the general location of mains, gates, hydrants, reservoirs, standpipes, pumping stations and other works connected with the system, preferably on a scale of from 600 to 1,000 ft. to 1 in. The sizes of mains up to 8 ins. in diameter may well be indicated by symbolic lines and those of larger sizes by figures. When the larger mains are drawn with heavier lines than the others the map will give a comprehensive idea of arterial system. All closed valves, including those along service limits, should be clearly indicated. Where the information is available, contour lines at convenient intervals should be added to the map; where these are not available the known elevations should be put on in figures, and in any case the exact elevations of the flow lines of all storage should be given.

The exact location of mains, gates, hydrants and larger service connections, and where desirable all service connections should be shown in detail on sectional sheets on a scale of from 40 to 60 ft. to 1 in. Where mains are not connected at street intersections this should be clearly shown, and it is desirable to note on these sheets the date when the mains were laid.

For the operation of the distribution system one or more sets of valve location books should be provided. These should be sufficiently in detail to enable intelligent operation of valves at complicated street intersections, and the location of the valves on large service connections should be included. A card index of valves should be kept showing location, make, type, size, direction and number of turns to close, depth below street surface, date set and all other necessary detail. A sketch showing the diagrammatic location of the valve with the ties may be placed on the reverse side of the card. Records should be kept of all repairs, inspections and operation of each valve; these may be in separate form or combined with card index.

Hydrant data, including location, date of installation, make, type, number and diameter of outlets, diameter of barrel, valve and branch, direction of opening, whether there is a gate on the branch, and other necessary information should be kept in card index form. Each hydrant should be given a serial number and records of inspection, condition and repairs should be kept either separately or on the cards.

Each service connection should be assigned a number and all data, including street number of property served, date of installation, kind and size of corporation and curb cock, pipe, curb box and stop and waste and meter, if provided, should be in card index form; a sketch showing location may be provided on the back of the card.

Consumption records should be kept in such form that the average daily consumption for each year, month and week and the maximum weekly, daily and hourly consumption can be readily obtained. This can be most readily accomplished by use of a meter of the Venturi type, having a continuous recording mechanism, although moderately accurate results can be compiled from the pump plunger displacement by making proper allowance for slip. Where reservoirs and standpipes are in service records should be kept of water levels, preferably by continuous recording devices. Complete records of pumping plant operation should be maintained in accordance with the prevailing modern practice. Continuous recording pressure gages should be maintained. One should be located in the principal mercantile district and others at such points as may be desirable.

Co-Operation Between Fire and Water Departments

The department should have a crew available at all times on short notice to handle emergency work and a motor vehicle equipped with tools should be available. At least one responsible employe should respond to fire alarms in mercantile districts and to second alarms elsewhere.

Fire alarms should be received in some quarters of the department and in all direct pumpage systems at the pumping station. Where pressures are raised or pumps are started upon receipt of fire alarms, fire alarms should be transmitted to the pumping station over duplicate fire alarm circuits. The foregoing standards of organization should assure the efficient operation of the system.

Adequacy of Water Supply

In considering the adequacy and reliability of a system it should be kept in mind that the function to be performed is to furnish domestic consumption and to get water on the fire. In order to determine the adequacy of the source of supply these requirements must first be determined. The records should show the average daily rate of domestic consumption and the maximum water consumed during any day within the last three years. In estimating the required fire flow an allowance is made for probable loss from broken connections and hydrants left open incidental to a large fire. Including this quantity, the total fire flow may be determined by applying the usual formula. In all cases consideration must be given to the structural conditions as found in the city and also to the number of companies in the fire department and the outside aid that would be available in case of a large fire. Illustrative of the application of the formula, a fire flow of 4,500 gals. a minute is required for the protection of the principal mercantile district of a city having a population of 22,000 and 12,000 gals. a minute for a city having a population of 200,000; cities having a population of over 200,000 require from 2,000 to 8,000 gals. a minute in addition to 12,000 gals. for a second fire.

Where fire engines are depended upon, the ability of the system to deliver the engine supply at a pressure of 20 lbs. in the mains is considered the ultimate capacity of the system. This residual pressure in the mains is deemed necessary to overcome the frictional losses in suction hose, hydrants and hydrant branches and to provide the necessary velocity head in order to deliver water to the fire engine in volume equal to its rated capacity.

Pressure

The pressure on the mains when the fire draft is being made, which is required to develop direct hydrant hose streams, is dependent mainly upon the height of the buildings; 75 lbs. pressure or more, depending upon the height of buildings and engine capacity in service, is necessary in high value districts; 60 lbs. where not more than 3 stories, and in closely built residential districts, and 50 lbs. in village mercantile districts, where buildings do not exceed 2 stories and in thinly built residential sections. If the fire flow available at these pressures is in excess of the engine capacity available, plus 1/3 the required fire flow, or if there are no fire engines, the protection is considered as being on a hose stream basis and the deficiencies in the water system to furnish the required quantity at the desired pressure are worked out, otherwise the deficiencies of the water system are based on the capacity of the system to deliver water at 20 lbs. The adequacy of the system is based upon all equipment and appurtenances being operated under normal conditions which obtain at time of fire.

The advantage of having pressures sufficient to deliver 10 per cent. of the required fire flow as hydrant streams is recognized, and where systems do not have this capacity an additional deficiency is applied in proportion to the number of pounds below the required pressure at which this quantity is available. Consideration is, however, given to the reliability of the source of supply, inasmuch as it may be influenced by droughts, floods, ice

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formations, silting-up or shifting of channels, physical condition of intakes, forest fires, danger from earthquakes and injury by physical means, and a deficiency is applied in proportion to the unreliability, bearing in mind that a total interruption of the supply is more serious than a reduction in the quantity available.

Reliability of Water System

Now that the adequacy of the system has been determined, the question of reliability in respect to its ability to maintain its normal capacity under various conditions is considered. Records maintained over a number of years show that certain failures, which result in partially or completely interrupting the supply, occur with sufficient frequency to merit consideration.

The number and total capacity of the pumps should be sufficient to allow maximum domestic consumption and the required fire flow to be maintained when the two largest units are out of service. The quantity of water held in storage and available to supplement the output of the group of pumps under consideration is taken account of in calculating the deficiency. Where there are low-lift as well as service pumps, the reliability of each group is considered separately and a deficiency charge is made for each.

Suitable credit is given for emergency supplies when available in proportion as they offset the deficiencies of the several parts of the system. The utilization of polluted supplies is not advocated and where such are available and have been used, credit is given for only ½ the points which these supplies decrease the deficiency of the system, because they will probably not be used until conflagration conditions have developed.

Boilers

A sufficient number and total capacity of boilers should be provided to deliver the required capacity as previously determined with one-fourth the entire capacity, and in any case one boiler in reserve. Where chimney capacity is ample, an overload of 50 per cent. for return tubular and 100 per cent. for water tube boilers over the maker's rating is allowed and credit is given for available water held in storage. Normally, there must be sufficient boiler capacity kept under at least ½ required pressure to deliver full requirements, in connection with storage, for a period of 2 hours.

Pumps

All equipment must be of a design suitable for the service, maintained in good condition and operated by a competent force. Pumps of the following types, when well designed and installed, are assumed as approximately equal, the advantages of each, if any, being in the order of their naming; centrifugal or reciprocating pumps driven by steam engines; centrifugal or reciprocating pumps driven by electric motor (the generating stations must meet the same requirements for reliability as those imposed on pumping station); pumps operated by water power; centrifugal or reciprocating pumps operated by internal combustion engines.

The supply of fuel must be assured and at least 5 days' supply should be kept on hand; oil should be kept in underground storage. Where gas or oil supply is unreliable, provision should be made for the use of coal. Any deficiencies in water power should be offset by a second source of power held in reserve.

Transmission Lines

Steam, gas, oil and feed piping or electric transmission lines should be so arranged that the failure of any line, or the renewal of any valve, transformer or oil or feed pump would not prevent maintaining, in connection with storage, maximum domestic consumption for 2 days and fire flow for 10 hours. In determining the unreliability of overhead electric lines consideration must be given to the character of poles and wires and of country traversed; prevalence of high winds, sleet and snow storms, and facilities for making repairs; the use of the same transmission line from transformer or switchboard by other parties introduces an undesirable hazard.

Fire Protection in Water Works Structures

Pumping stations and other portions of the plant should contain no combustible material in their construction; otherwise an automatic sprinkler equipment must be provided. In any case the stations should be protected against exposures and hydrants and inside standpipes with hose and chemical extinguishers should be provided. If pumping station is not fireproof, the several sections, particularly any with high-potential generating or transforming equipment should be separated by parapeted fire walls and openings protected by at least a single, standard fire door or wire glass in metal frame. Electric wiring shall be installed in accordance with the National Electrical Code, and all internal hazards, such as oil and waste, properly safeguarded.

Breaks in Supply Line

The effect of a break in any pipe or conduit line on which supply to the distribution system is dependent must be considered in determining the reliability of the supply mains. Aqueducts of good design and of substantial construction, such as masonry or concreted steel, when reliably installed, shall be considered sufficiently dependable as not to require duplication. In determining the failure which will result in the greatest reduction of the supply, all mains which deliver from the source of supply or of storage to the principal mercantile district must be considered; these will include suction or gravity lines to pumping stations, flow lines from reservoirs, force mains, as well as arterial feeders within the distribution system. In determining the effect of any break the storage available must be considered, and in calculating the quantity available from such source it is assumed that 5 days will be required to make necessary repairs. In designing suction and discharge headers, piping at reservoirs and filters, by-passes and cross-connections, particular attention should be given to the feature of reliability. This feature is frequently overlooked and single failures result in complete or serious reduction in the supply, when little or no additional expense would have been involved to provide the necessary reliability.

In determining the points of deficiency for the preceding items which pertain to reliability, except for that covering pumping station buildings, it is recognized that the probability of large fires occurring while any portion of the works is out of service is not so great in the smaller cities and the points of deficiency are reduced 10 per cent. for each 1,000 gals. fire flow required below 5,000 gals.

Pipe Lines

In addition to the effect produced by a single break the probability of such a break occurring must be considered.

Cast-iron, wrought-iron, wood-stave, reinforced concrete and masonry conduit have been found satisfactory in various places and under certain conditions, but account must be taken of the general condition. The service record should be taken into consideration in judging of the reliability of these lines, together with the probability of their failure at stream crossings and railroad crossings, where physical injury might occur; it is preferable to have mains laid far enough apart so that they will not endanger each other. The mains should be cross-connected about once a mile and equipped with suitable valves and blow-offs to enable shut-offs and repairs to be made promptly. Such mains are considered moderately unreliable when the repairs of one valve would result in the total interruption of the supply.

The deficiency of the arterial system is based upon the results of the fire-flow tests and a general consideration of the arrangement of the large mains. These should be of sufficient size to deliver the required flow into the several districts in addition to the maximum daily consumption rate, and so looped that no large area will be dependent upon a single main; in general, large mains should be so spaced that they will not be over 3,000 feet apart.

The large mains should not be laid in filled ground and should have special construction at railroad crossings and near bridge abutments; cover must be sufficient to prevent freezing and at least 2 feet is required to prevent injury from traffic. Gate valves should be set at intervals of not more than ¼ mile, and where connections to the intersecting smaller mains are made with run-arounds fewer valves have to be closed in case of accident than where these connections are made with crosses.

Size of Pipe

Four-inch pipe does not have sufficient carrying capacity to furnish fire protection, and a deficiency is applied in proportion to the percentage of this size of pipe in the system which supplies hydrants. Six-inch pipe is considered the minimum size satisfactory for hydrant supply in residential districts, and only when closely gridironed with cross-connecting mains 6 ins. or larger in diameter at intervals not exceeding 600 ft. Where pressures are lower than about 40 lbs. a satisfactory supply cannot be obtained from 6-in. pipes except where the blocks are small. In high-value districts 8, 10 or 12-in. pipes are required. It frequently happens that although the required quantity of water can be delivered in portions of the high-value district there are other parts where, due to elevation or small pipes, this quantity cannot be obtained; a charge is made for this deficiency.

In the course of development of any system it is impossible to eliminate all dead ends, but 8-in. pipe should be used where dead ends or poor gridironing is likely to exist for some time. A charge is made for dead ends and poor gridironing of 6-in. and smaller pipes, and this charge is reduced in proportion to the pressure carried in excess of 20 lbs., where fire engines are dependent upon and 60 lbs. where direct hydrant hose streams are used.

Cement-lined and wood-stave pipe are unreliable when in a distribution system, and a charge is made in proportion to the length of such pipe or other unreliable pipe found in the system; the danger of electrolytic action is also considered.

In order that hydrants may not be put out of service in too large an area or the carrying capacity of the distribution system seriously reduced, it is necessary to equip the distribution system with a sufficient number of gate valves so located that no single case of accident, breakage or repair to the pipe system will necessitate the shutting from service of a length of pipe greater than 500-ft. in high-value districts, or greater than 800 ft. in other sections, and will not result in shutting down a main artery. All valves should be inspected yearly, and the larger valves more frequently. If valves do not operate in a uniform direction, the spindles should be replaced to secure uniformity.

Hydrants

Hydrants should be of such design that they can deliver 600 gals. a minute with a loss of not more than 2½ lbs., and a loss of not more than 5 lbs. between the street main and the outlet; 4-in. hydrant branches are too small to accomplish this result. All hydrants should have at least two 2½-in. outlets and where engines are used, large suction connections should be provided. Hydrants should be so designed that they will remain closed when broken off; this is of particular importance because of the large number of such accidents dut to the careless driving of motor vehicles. Flush hydrants, particuarly where heavy snows are common are undesirable and cisterns cannot be considered of proper type.

The distribution of hydrants is worthy of thorough study for any deficiency in number or uniformity in distribution prevents the required quantities being concentrated on a fire. Satisfactory distribution requires that two-thirds of the required fire flow be delivered on the fire through hose lines, none exceeding 500 ft. in length when direct hydrant streams are depended upon and none exceeding 600 ft. in length where engines are used. The linear spacing is not the true measure of distribution. This will be readily seen when the size of the block is considered; where blocks are 200 ft. square one hydrant at each street intersection gives an extra area served of 40,000 sq. ft. and a linear spacing of 200 ft., and where blocks are 700 ft. square in order to get one hydrant for each 40,000 sq. ft. it is necessary to set hydrants each 120 ft. along the streets on all sides of each block. From the above it is seen that where hydrant streams are depended upon more hydrants are needed than when engines are used, and in either case, the area served is dependent upon the fire flow required. Where engine streams are used, the areas served per hydrant in square feet for required fire flows in gallons per minute are as follows:

1,000 g. p. m.	120,000 sq. ft.
3,000 g. p. m.	100,000 sq. ft.
5,000 g. p. m.	85,000 sq. ft.
7,500 g. p. m.	65,000 sq. ft.
10,000 g. p. m.	48,000 sq. ft.
12,000 g. p. m.	40,000 sq. ft.

where direct hydrant hose streams are used:

1,000 g. p. m.	100,000 sq. ft.
2,000 g. p. m.	85,000 sq. ft.
3,000 g. p. m.	70,000 sq. ft.
5,000 g. p. m. and over	40,000 sq. ft.

Hydrants should be inspected in the spring and fall of each year, after use at fires during freezing weather, and daily in high value districts during protracted periods of severe cold.

Hydrant branches on large mains should be equipped with a gate valve and where the distribution system is not equipped with sufficient gates to comply with the requirements previously set forth, gates should be installed in the branches served by the smaller mains. It is generally more economical and at the same time is considered better practice to equip the smaller mains within the gridiron of the distribution system with a sufficient number of valves rather than to equip the hydrant branches with gates.

An inspection of the water system enables the percentage deficiency of each part of the works to be determined in respect to the standard and from the percentage thus determined a charge in points is made from a deficiency scale which has been prepared of the points of deficiency corresponding to the per cent. of deficiency. In determining the points of deficiency for any given percentage of deficiency consideration was given to the fact that the seriousness of deficiencies is not so great when the item under consideration is only slightly below the standard and again the value of a seriously deficient item is not proportionately so great as of one less deficient. It is also obvious that the relative values of the items considered in the before enumerated standards are not equal and their importance is properly weighted in points by multiplying the points found in the deficiency scale by a factor corresponding to their importance. For instance, a deficiency in adequacy of capacity of the system to furnish average consumption and fire flow is charged at 2 times deficiency scale while the deficiency to furnish maximum domestic consumption and fire flow is charged at only ½ deficiency scale.

Similar standards have been established to cover fire department, fire alarm and the remaining features of the fire defenses of a city. With these standards established and properly applied in accordance with the schedule the classification can be determined with accuracy approaching that obtained by measuring a distance with a steel tape. In other words, the grading schedule has established a unit of measure by which fire defenses can be surveyed with accurate results. Each of the standards has been described in brief form but with the ideas that the fundamental principles were set forth in such manner that the engineer and superintendent could deduct the interpretations applicable to the particular works under consideration and if these principles are followed, even though the lack of funds may preclude a complete compliance, a more adequate and reliable works will result than if they be disregarded.

THE DETECTION OF LEAKS IN UNDERGROUND WATER PIPES

By H. E. Babbitt, Asst. Prof. Municipal and Sanitary Engineering, University of Illinois, Urbana, Ill.

Locating Leaks by Observation.

The simplest method for location of leaks is by observation, if it can be called a method. It would scarcely seem to take much experience to say "there is a leak" if water is seen bubbling up in a city street. Peculiarly the visual evidence may be sufficient to demonstrate the existence of a leak but its exact location may not be immediately below the point at which the water is appearing. However, the thing to do is to dig at the point where the water is appearing, and if water is found coming in from the side of the hole, the follow along until the leak is reached or to use one of the more simple methods subsequently described. A water works superintendent who observes a luxuriant growth of vegetation along the line of his water pipes in the midst of a hot dry spell is safe assuming that his pipes are leaking nearby and that an appreciable saving can be made by stopping the leak located there. If a sewer or drain pipe is seen to be discharging continuously even during the driest weather, suspicion should be directed to the line of water pipe that the drain crosses as contributing the flow through a leak.

Using Sounding Rods.

Leaks discovered by observation in this fashion may follow along the pipes for some distance before making an appearance. If the leak is not located in the excavation made at the place of appearance, a pointed steel rod about ½ to ⅜ in. in diameter and 5 to 6 ft. long can be driven down to the pipe through most soils. If on withdrawal the rod is found to be moist the indications are that the leak is further upgrade, and on withdrawing the rod in a dry condition the leak has been passed and lies between the last two points of driving the rod. Such a rod is called a sounding rod.

Locating Leaks by Sound.

Sounding rods have no relation to the detection of leaks by sound which is the most common manner in which leaks are located which is worthy of the name "method." The sound caused by a leak from a water pipe is a function of the velocity of flow, the size and condition of the opening, and whether the leak is discharging under water or into the air. A high velocity through a small aperture will make more noise than a large discharge through a large aperture. A free discharge will be more noisy than a submerged discharge. It is a well known law of physics that sound will travel faster and further through a solid body than through gas. If leaking is taking place in a pipe the sound will be transmitted by the pipe for long distances. The sound can be picked up by placing the ear against the pipe or some fixture connected thereto, or better by the assistance of some of the instruments made for the amplification of sound.

The Aquaphone.

The aquaphone, or water phone, is the simplest instrument and the most commonly used. The device consists of a solid metal rod soldered to the center of a thin metal diaphram as used in an ordinary telephone receiver. The point of the rod protrudes from the end of the receiver and is placed in contact with the pipe or fixture. The leak is located by following along the pipe as the sound increases. If the pipe is buried a sounding rod may be driven down to make contact with it. The aquaphone is placed in contact with the sounding rod. Considerable experience is necessary for the successful use of this instrument.

Other Sound Amplifiers

The detectaphone, the sonograph, the sonoscope, the

geophone, etc., are somewhat similar instruments. The volume of sound in some of these instruments is increased by an electrical amplifier placed in line between the point of contact and the receiver. The receiver is similar to the ordinary telephone instrument with electrical coil and magnet. The sound waves set up in the pipe are converted to electrical waves, amplified and transmitted to the receiver, much more loudly and clearly.

It is to be noted that all of the instruments described so far require direct contact with the pipe. This may be a decidedly undesirable feature as the exact location of a leak in a buried pipe may require that excavations be made in order to reach the pipe. The sounding rod does not always work well with the aquaphone.

Darley's Leak Locator

Darley's Leak Locator is a sound detecting instrument that does not require direct contact with the pipe. A very delicate sound detector is set up on a four-legged brass table which rests on the surface of the ground, and is protected from air currents by placing the box containing the electrical cells over it when in use. The vibrations set up in the detector are converted to electric waves which are transmitted through an amplifier to a very sensitive telephone receiver. The instrument is so sensitive that it will detect the sound of a leak through the pavement and the ground at the ordinary depths to which water pipes are buried. The instrument cannot be used in a high wind or where other noises may interfere. Satisfactory results have been obtained with its use.

Utilizing Water Hammer in Locating Leaks

The phenomenon of water hammer is useful in locating a leak in a water pipe. It is well known that if a valve in a pipe line is closed quickly a pressure is set up in the pipe. This pressure is called water hammer. It differs from the effect caused by a blow in that the pressure is maintained for some time. A wave of high pressure travels from the valve up the pipe to a point of relief and a wave of low pressure then returns to the starting point at the valve. The pressure at the valve fluctuates above and below normal until the disturbance has become stilled by the friction of its passage through the pipe, and the pressure returns to normal. Intermediate discharges between the valve and the point of relief will cause fluctuations in the pressure at the valve after the water hammer has been created, and if many of these intermediate discharges exist the fluctuations of pressure will be too confusing to be of value. The speed at which the wave travels is affected by the diameter of the pipe, its material, and other factors and varies between 3,600 and 4,200 ft. per second. In the application of this phenomenon to the location of a leak, the approximate location of the leak should be determined and the line of pipe on which the leak is located should be isolated by closing of valves so that it is connected to only one large service main, preferably much larger than the pipe in question. It may be necessary to shut off service connections or to apply the method at night when the service pipes are not drawing water. A quick shutting valve is attached to a hydrant so located that the leak is between it and the water main. The distance from the hydrant to the connecting main along the pipe line should be measured accurately. A delicate recording pressure gage is attached to another nozzle on the hydrant. The dial is revolved by clock-work. Time is recorded by the vibrations of a tuning fork. After the instruments are connected up and the clock is running, the valve is opened and water allowed to flow from the hydrant. The valve is then closed suddenly. On the closing of the valve the pressure will jump up. The pressure will remain at this height until a slightly relieving wave has returned from the point of the leak when it will drop a little. The pressure will then remain constant until the low pressure wave has returned from the point of relief. The exact location of the leak is then determined by proportional distances from a diagram of the variation in the water pressure.

Use of Chemicals in Locating Leaks

A method requiring the use of chemicals was suggested by T. J. Hoxie in the Journal of the New England Water Works Association, Vol. 27, page 307. The leak is located tentatively within a certain section of pipe which is then isolated. It is essential that all service connections be closed. A corporation cock is tapped into the main somewhere above the leak. To this is connected a 6 to 8 in. length of 2 or 3 in. pipe and a valve. Two or three pounds of caustic soda are inserted in the tube, the large valve closed, and the time of opening of the corporation cock noted. Samples are collected at various points along the line and tested for alkalinity with phenophtalene. As soon as the alkalinity is found at any one point it indicates that there is a leak beyond that point because the flow created by the leak has carried the chemical down. Finally a point will be reached where the alkalinity does not appear. The indication is that the leak is somewhere between this point and the point at which it was last found. Water is withdrawn at the point at which the alkalinity has not appeared and the quantity withdrawn before the alkalinity does appear is carefully measured. This quantity, divided by the volume per unit length of the pipe will give the distance to the leak. Any number of leaks can be detected in this fashion.

Utilizing Volumetric Displacement

An ingenious method based on volumetric displacement was used for the location of a leak in a pipe line during the construction of the Field Museum in Chicago. A piston was made which fitted the inside of the pipe. A Y-branch was inserted in the pipe line, the piston was put in the pipe. through this branch and a cable attached to the piston was passed through a packed joint in the plug closing the Y-branch. The water was then gently turned in the pipe just sufficiently to keep the piston moving. When it had reached the leak it stopped and the length of the cable measured the distance to the leak.

Leak in Submerged Line

A simple method for the location of a leak in a submerged pipe is to dump a quantity of bluing in the line. The appearance of the bluing in the river or harbor will locate the position of the leak. Other equally difficult methods may be as effective as the more scientific methods just described.

Wireless Pipe Locator

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is an instrument available known as the wireless pipe locator by which the exact location of the pipe can be determined. This apparatus is manufactured by the H. W. Clark Company of Mattoon, Illinois. An electric circuit is made by connecting two points on the pipe line by an electric wire. A battery and vibrator are put in this circuit, the vibrator serving to interrupt the current rapidly. An induction coil and a detecting coil connected to a telephone receiver are carried in the hand. When the induction coil held in a horizontal position is brought into the vibrating electric field, set up by the electric circuit through the pipe and wire, a singing noise is heard in the telephone receiver. The volume of sound increases until directly over the pipe when it ceases altogether. If the coil is then turned in a vertical position the loudest sound is heard.

The foregoing paper by Prof. Babbitt was presented at the 1920 convention of the Illinois Section of the American Water Works Association.

STRIPPING A SANDPIT BY BLASTING

It has been common practice for years to use dynamite for stripping top soil from iron ore beds, shallow coal deposits, stone quarries, etc., but it is unusual to blast the top soil from sand and gravel pits; yet the method is equally applicable to such work and saves as much time and labor in the one as the others.

A description of the method employed by the Washington Sand and Gravel Company at their works near Bladenburg, Maryland, may be of interest to other producers of these materials.

The pits are located at the side of a creek or small river. The sand is loaded on boats by means of a floating suction dredge operated on the creek. To get at the sand, it is necessary to strip off 4 to 6 ft. of top soil. This stripping is now done by blasting with dynamite. A shot recently observed was loaded as follows:

Bore holes were put down vertically, 4 ft. deep and located 8 ft. back from the creek bank. In this shot, there were seven charged holes, 2½ ft. apart in the row. Five cartridges of 40 per cent. ammonia dynamite 1⅛ x 8 was the charge in each hole. Each charge was primed with an electric blasting cap and the firing done with a blasting machine. The shot removed the top from the section blasted, throwing most of the dirt into the creek.

It is figured that the cost of the blasting is more than balanced by the saving in the time and cost of operating the dredge to remove the top. This work was all waste, because no use could be made of the top soil.

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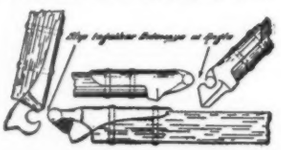

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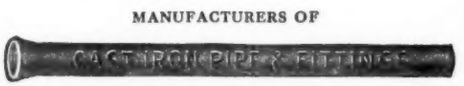

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CONSTRUCTION NEWS AND EQUIPMENT

CENTRAL MIXING PLANT MAKES NEW PAVING RECORD AT BIG LAKE, MINN.

(Editor's Note—Since the following article was written the record therein described has been broken on the same job. The contractors report a run of 1,094 ft. on this 18-ft. road, 7 ins. thick, in eight hours. They are not yet fully equipped with trucks and so cannot handle the mixed concrete to the full capacity of the mixer. When they get their 12 trucks with dump bodies running they expect to raise their record to over 1,200 ft. of finished pavement in eight hours).

Where conditions warrant the use of a "central mixing plant" for paving work, it has usually been contended that this method is exceptionally speedy. It is interesting to note, therefore, that a new world's record for a single day's production has been established by McCree, Moos & Co., St. Paul highway contractors, using a 1-yd. Smith Tilting Mixer, operated as a central mixing plant.

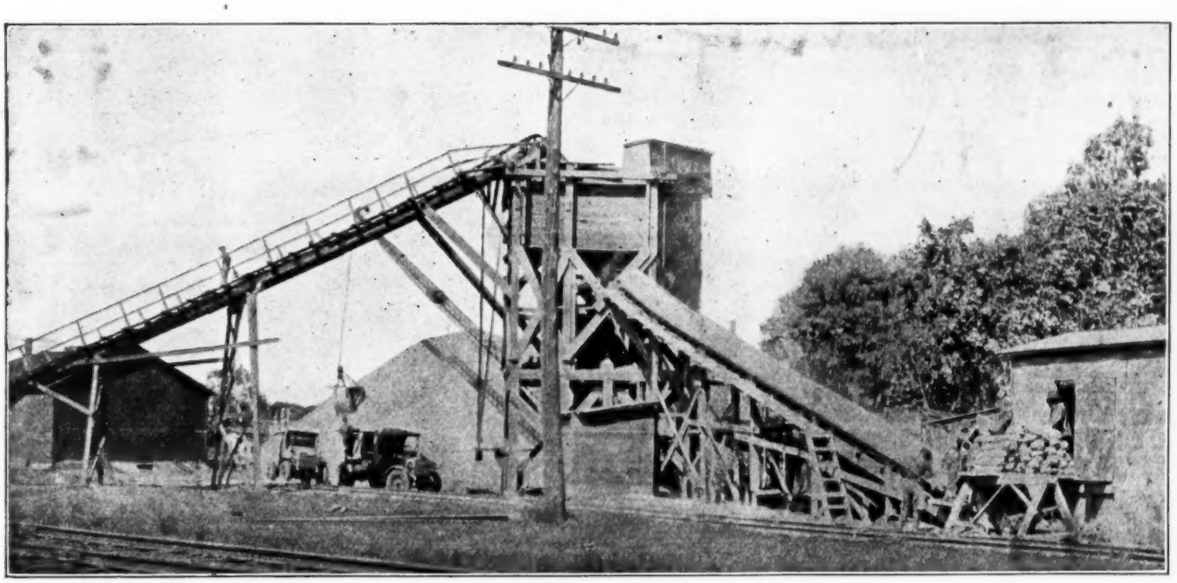
The total yardage laid by the central mixing plant in 10 hours was 355 cu. yds., the record day's production being 912 lin. ft. of 18-ft. road, average thickness 7 ins. The world's record using the paving mixer method, as established by Alan Jay Parrish at Paris, Ill., was 308 cu. yds., the record production for 10 hours being 779 lin. ft. of 8-in., 16-ft. road.

By these records, the central mixing plant method produced over 15 per cent. more road than the paving mixer method. State specifications on both jobs required a full minute mix per batch.

The details contributing to this 912 ft. record are worthy of careful study. The McCree, Moos contract covers 7½ miles of road running north and south from Big Lake, Minn. The central mixing plant was located in Big Lake at the half-way point of this road so that the maximum haul for the mixed concrete to either extremity of the road was 3¾ miles.

CONCRETE DELIVERED TO ROAD BY TRUCK, SPREAD BY HORSE-DRAWN SCRAPERS BETWEEN HELTZEL STEEL FORMS, TAMPED AND FINISHED BY MACHINE.

It is an 18-ft. highway, one course concrete pavement, 6½ ins. thick on the sides and 7½ ins. thick in the center, the average thickness being termed 7 ins. A 1-2-4 mix was used, as allowed by the State of Minnesota when a machine tamper and finisher is used. The State specifications on "composition" are as follows: "This concrete shall be composed of 1 part Portland Cement, 2 parts fine aggregate and 3½ parts of coarse aggregate unless the machine tamper and finisher is used, in which



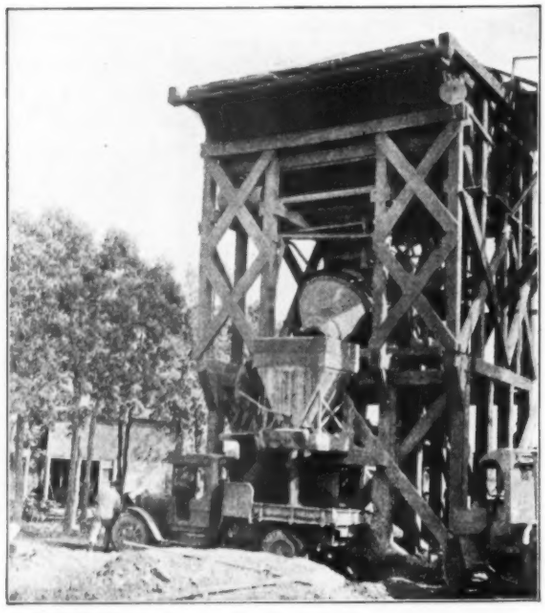
CENTRAL MIXING PLANT ON BIG LAKE, MINN., ROAD CONSTRUCTION JOB, ILLUSTRATING SIMPLE METHOD OF LOADING HOPPERS WITH SAND, CEMENT AND STONE.

Printed as insert to MUNICIPAL AND COUNTY ENGINEERING, Chicago, Ill., November, 1920.

case 4 parts of coarse aggregate may be used."

The State's clause specifying "consistency" reads as follows:

"Sufficient water shall be used in mixing to produce a concrete which will meet with the following test: When



SMITH TILTING MIXER DISCHARGING INTO TRUCK WITH ORDINARY DUMP BODY, AT CENTRAL MIXING PLANT.

placed and tamped in a cylinder 6 ins. in diameter and 12 ins. high and the form removed, the concrete shall have a vertical settlement of not more than 2 ins. when machine finishing is employed and not more than 6 ins. when hand finishing is employed."

The dry mix was necessary, therefore, on this job and the central mixing plant proved its practicability thoroughly even with this mix.

The clause specifying "Mixing" reads as follows: "Concrete shall be mixed to designate consistency in a batch concrete mixer of the approved type until the cement is uniformly distributed and the concrete is homogeneous and uniform in color. Each batch shall remain in the mixer at least one minute and have not less than 12 nor more than 18 full turns of the mixing drum. The mixers shall be equipped with a timing device. Retempering or remixing concrete that is partially hardened will not be permitted."

A full minute mix was strictly used. McCree, Moos & Company had a batch meter of their own make on this Tilting Mixer which merely rang a bell at the end of the required number of revolutions of the drum, but which did not register these revolutions. The State Highway Engineer permitted them to use this batch meter instead of one furnished on the Smith mixer.

The handling of materials at the central mixing plant is very efficiently and simply arranged. The cement, in bags, is unloaded direct from the cars into a warehouse at the plant. A belt conveyor leads from the warehouse to a hopper directly over the mixer. The bags are opened in the warehouse and the cement, six bags at a time—enough for one batch—is dumped upon the belt conveyor which carries it up to the cement hopper.

The sand is brought from a pit 1¾ miles away to the central mixing plant, by 2½-ton end-dump trucks with Lee bodies. The trucks deposit the sand into a trap, from which another belt conveyor elevates it to a second hopper over the mixer. This sand hopper has a capacity of 20 yds.

The crushed stone is St. Cloud granite and is shipped to the plant in gondolas. A 1-yd. clam shell bucket on an 85-ft. boom derrick unloads from these cars directly into a third hopper over the mixer. The stone hopper has a capacity of 25 yds. When filled, the surplus crushed stone is unloaded into a stock pile behind the derrick and then the hopper is kept supplied from this stock pile.

The batch hopper of the mixer is subdivided to hold the correct proportions of cement, sand and crushed stone, which are fed into the batch hopper from the respective material hoppers directly above it.

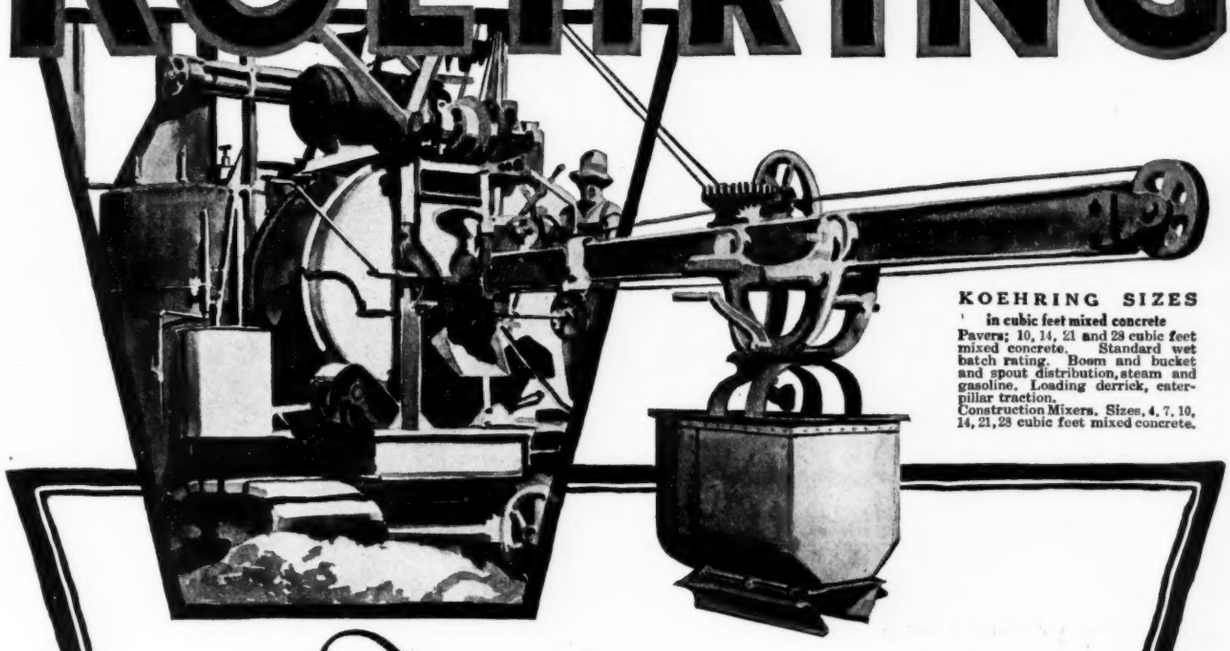
After the one minute mix the mixer tilts and discharges its entire batch in 8 seconds into a bottom dump hopper arranged just high enough to permit the trucks to drive in beneath it. This hopper for the mixed concrete will hold two full batches, 2 cu. yds.

The wet concrete is carried to the road by motor trucks, 2½-ton capacity, special short wheelbase, equipped with end-dump bodies manufactured by the Lee Loader & Body Co., Chicago. These bodies have a level capacity of 2 yds., but are usually loaded with about 1½ yds. of concrete. The contractors are using 3,000 ft. of Type L 6 in. Heltzel Standard Road Forms on this job.

TRUCK WITH LEE BODY READY FOR A LOAD OF MIXED CONCRETE AT CENTRAL MIXING PLANT.

The first stretch of road laid on this contract was started a mile and a half north of the mixing plant, working south. When this section had been completed up to the mixing plant, the work was started a mile and a half south of the town of Big Lake, working north. When this three mile section was completed and ready for traffic, the work was started at the extreme northern extremity of the road, 3¾ miles from the mixing plant,

KOEHRING



KOEHRING SIZES
in cubic feet mixed concrete
Pavers; 10, 14, 21 and 28 cubic feet mixed concrete. Standard wet batch rating. Boom and bucket and spout distribution, steam and gasoline. Loading derrick, caterpillar traction.
Construction Mixers. Sizes, 4, 7, 10, 14, 21, 28 cubic feet mixed concrete.

The fastest Paving Unit

HIGHEST speed operation in charging materials into drum because of high angle charging position of charging skip.

Fastest, easiest controlled discharge because of discharge chute pivoted inside the drum, and arrangement of blades and pick-up buckets.

All these features combined into the fastest paving unit by Koehring exclusive automatic actions which enable operator to maintain day-long, top speed operation—and all supported by the Koehring Heavy Duty Constuction.

Fastest distribution of any consistency of concrete to sub-grade because of Koehring boom and bucket distributing system, the greatest distributing range without moving the mixer.

Write for Mixer catalogue and Mixer Loader catalogue.

Mechanical Loading

Loading derricks to lift batch boxes from cars or trucks to charging skip. Koehring Mixer Loader when materials are placed on sub-grade cuts out all wheelers.

Koehring Machine Company
Milwaukee **Wisconsin**

working south again. This system enables the trucks to travel a mile and a half over the new concrete road with their loads of concrete and continually cuts down the stretch that has to be traveled over the unpaved road.

One of the interesting points about this job is that the 912-ft. record is not at all indicative of the real capacity of this central mixing plant. The amount of pavement laid depended entirely upon the transportation facilities for the concrete. Not nearly enough trucks were equipped with the Lee bodies to work the plant to its full capacity.

More trucks are required, of course, when the haul is to the extremities of the road than when paving near the mixing plant. For instance, on the first mile and a half, while paving not more than half a mile from the plant, with only four trucks they succeeded in laying 883 lin. ft. in one day. Then, with seven trucks, paving the section at the furthest extremity of the road, they made their 912-ft. record in one day. If they had had their complete fleet of 12 trucks available for this work the record could have been far greater as the mixing plant had to wait repeatedly for the trucks to handle the concrete.

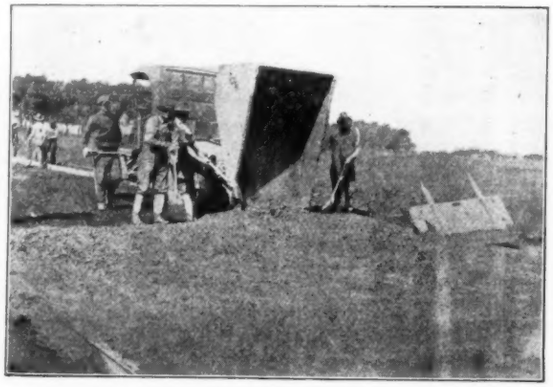
On this job, McCree, Moos & Company have made the remarkable average daily record of 1,100 sq. yds. or 550 lin. ft., for several weeks on this 7-in., 18-ft. highway.

DUMPING MIXED CONCRETE FROM ORDINARY MOTOR TRUCK WITH DUMP BODY.

The history of the old Tilting Smith Mixer used on this job is interesting. It is a "second-hand" mixer, sold originally by the T. L. Smith Co., Chicago, to A. Guthrie & Co., Blue Island, Ill., in 1916. It was used on the big project of the Calumet Sag Channel at Blue Island and was finally resold to McCree, Moos & Company after that job was completed. Originally it was equipped with electric motor but was resold without the motor. On the present job, a motor is mounted near the ground and the power is transmitted by a long belt to the mixer up on the scaffold. With the exception of this new motor, the old Smith Tilting Mixer is just as it was originally in 1916, including the batch hopper and all.

The belt conveyors are also "second-hand" equipment, but the records of production prove that the work is being accomplished in a first-class manner.

Comparing the two methods of paving—the paving mixer method and the central mixing plant method—the total yardage speaks favorably for the central mixing plant. Considering, however, that the paving mixer had a ¾-yd. mixed concrete capacity and was working with



THE LEE END-DUMP BODIES DISCHARGE QUICKLY AND COMPLETELY.

a 1-2-3-½ batch instead of a 1-2-4 batch, (shrinkage being somewhat more on the 1-2-3-½ mix), the percentage of increase of the central plant over the paving mixer is somewhat minimized. On the other hand, the central plant in this case was somewhat handicapped by insufficient transportation of the mixed concrete.

It is certain, however, that both methods have been successfully employed and it is important that conditions on every paving job should be carefully studied in order to determine which of the two methods is the more practicable and profitable under the existing conditions.

NEW ALL-MULTIPEDAL TRENCHING MACHINE CLIMBS CURBS AND CROSSES SIDEWALKS TO DIG HOUSE CONNECTION TRENCHES

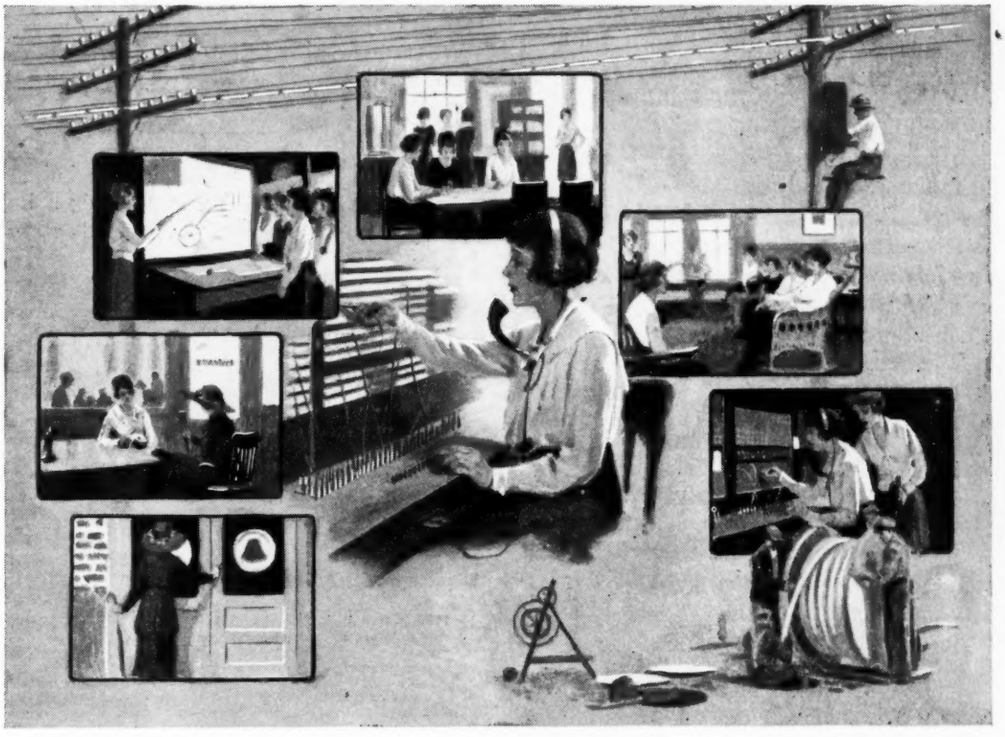
A new type of trenching machine, now being placed on the market, and here illustrated, is designed to turn practically within its own radius. It has full multipedal traction and is strictly a "one-man" machine.

The full multipedal traction steers through heavy friction clutches—one on each side—its action in this respect being similar to the military tank. It is of sufficiently light weight to handle efficiently trenches or house connections, sewers, etc. The machine will cross sidewalks, climb over a curb, cross bridges, and travel over any and all types of pavements, thereby reducing to a minimum the danger or damage claims.

Its road traction speed is higher than that of ordinary trenching machines.

A screw hoist raises and lowers the digging arm automatically, and the endless chain and buckets are of standard type. This screw hoist also acts effectively, because of its construction, as a lever to force the buckets to dig, by crowding the bucket line against the face of the ditch or cut.

A cleaning device takes care of the sticky dirt, and



Training For Service

What science and engineering have done to develop the mechanical efficiency of the telephone, specialized training has done in the development of workers.

Plant engineers, linemen, directory clerks, toll operators, equipment installers, electrolysis engineers, trouble hunters, line repairmen, test table operators, chief operators, contract agents, building engineers, line installers, exchange repairmen, plant inspectors, trouble operators, fundamental plan engineers, draftsmen, estimate clerks, exchange operators, cable testmen, equipment inspectors, wire chiefs, traffic engineers, galvanometer men, cable splicers, facilities engineers, surveyors, information operators, switchboard installers, accountants, testmen, supervisors, station repairmen, equipment engineers, directory operators, statisticians, appraisal engineers, routing operators and scores of other skilled employees are specially trained for the exacting work of providing telephone service.

Throughout all work of telephone construction and operation there is a ceaseless endeavor at mastery of service that makes for improvements beneficial to the public.

AMERICAN TELEPHONE AND TELEGRAPH COMPANY
AND ASSOCIATED COMPANIES

One Policy *One System* *Universal Service*
And all directed toward Better Service

scrapes out each bucket as it passes a point at the head of the excavator boom, directly over the conveyor belt. This can be adjusted to deliver the excavated material to either side of the machine.

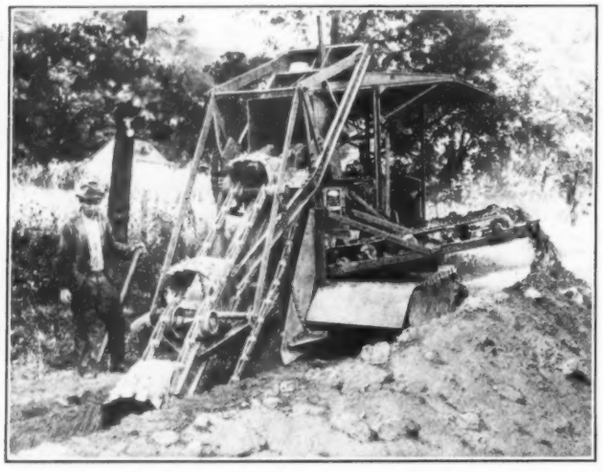
Strength and weight have not been sacrificed in order to secure a short-based, mobile and very speedy digger, thereby keeping it in the already well-known family of Austin trenching machines.

The illustration shows this new All-Multipedal Austin machine at work on trench excavation.

The gasoline engine is of 4 cylinder cycle type, cooled by an enclosed radiator.

Some of the details which are of interest to sewer, water, gas, electric and oil pipe line contractors and corporations are as follows:

The digging width, with 18-in. buckets, will run from 20 ins. to 28½ ins., and with 24-in. buckets, from 26½ ins. to 29 ins. The standard boom will dig up to 6 ft. in with an extensive equipment for digging 8 ft. deep. The traction accommodates itself to irregular surfaces, as the equipment consists of two oscillating multipedals. Each depth, although the machine is substantial for service



THE AUSTIN ALL-MULTIPEDAL TRENCHING MACHINE IN OPERATION.

one of these multipedal tractions is driven independently of the other by a friction clutch, so that in turning in a confined space, one may be stopped while the other is going ahead, turning the machine practically within its own length.

The digging speed naturally depends upon conditions of the soil and the depth of trench, but the machine will dig at a phenomenal rate of speed.

The conveyor belt is reversible, so that it can deliver dirt on either side. Adjustable screws are provided for taking up the slack.

The power and mobility of this machine, and its extreme flexibility, will enable the operator to do work in many places where the ordinary machine cannot go at all, and at the present it is the only All-Multipedal traction trenching machine built.

An important feature of the working performance is its ready interchangeability for digging trenches with vertical banks or small ditches with sloping sides.

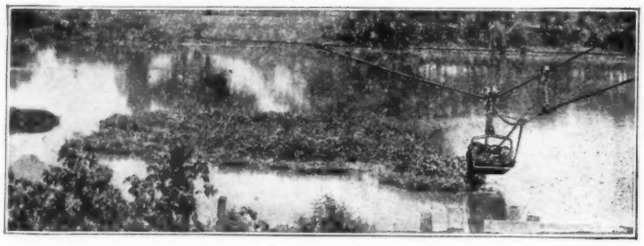
METHODS AND EQUIPMENT EMPLOYED ON NEBRASKA GRAVEL ROADS

The road from Fremont to Ceresco, Nebraska, has been called, by some, the "best road in the State," says the Monthly Report of the Nebraska Department of Public Works. The method of surfacing the road is a departure from the generally accepted manner of constructing a gravel road.

Grading

Little need be said concerning the building of the earth road before the gravel was applied; a brief description will suffice. Beginning at the north end of the project,

MATERIAL-HANDLING SIMPLIFIED



THERE is a growing appreciation among engineers and contractors of the fact that the dragline cableway excavator method, so universally employed by commercial gravel-handling plants, can be utilized for other work involving excavating and moving materials over distances of from 100 to 800 feet or more.

The ability of the Sauerman Dragline Cableway Excavator to dig from either above or below water, and to elevate and convey materials from pit to plant without the help of auxiliary machinery, is the reason for its popularity among sand and gravel producers. This same ability makes our type of equipment correspondingly economical and efficient for a wide variety of other material-handling operations, and it is now being successfully used for cleaning reservoirs, building levees, rehandling coal, deepening rivers, reclaiming material from stock piles, loading ballast, etc., etc.

For further information send for our catalog, or lay the details of your problem before us and we will submit our recommendations on equipment.

SAUERMAN BROS., 1142 Monadnock Bldg., Chicago

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THE SCOOP CONVEYOR

THOUSANDS IN USE

FOR STORING AND RECLAIMING
LOADING AND UNLOADING
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SAVES 6 TO 12 MEN
SAVES CAR DEMURRAGE

ELIMINATES SHOVEL AND WHEELBARROW WORK
KEEPS EQUIPMENT MOVING

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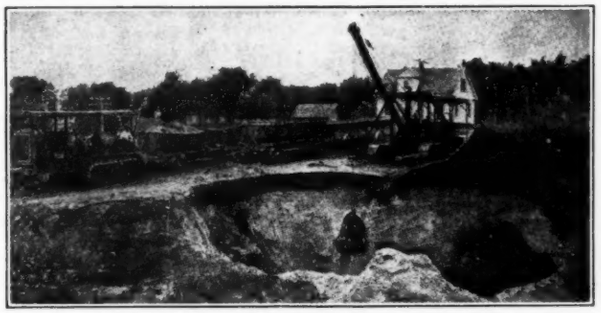
PORTABLE MACHINERY CO., PASSAIC N.J.

which is 33 miles long, the road from the end of the Fremont bridge on— a distance of three miles, contains considerable heavy cut and fill. Then follows 14 miles of comparatively level road, with no excavation beyond the ordinary ditch cut made necessary in grading the road. The next 5 miles are rolling and the last 6 miles partly rolling and partly level. The construction is in no



EQUIPMENT USED IN BUILDING FREMONT-CERESCO, NEBRASKA, ROAD AND VIEW OF PIT FROM WHICH GRAVEL IS EXCAVATED FOR SURFACING THE ROAD.

way unusual nor remarkable, with the exception of several heavy cuts at the beginning of the project and an especially large culvert, 175 ft. long. About 6 miles of the total 33 miles were completed March 27, 1920, and the entire earth work completed Aug. 2, 1920.

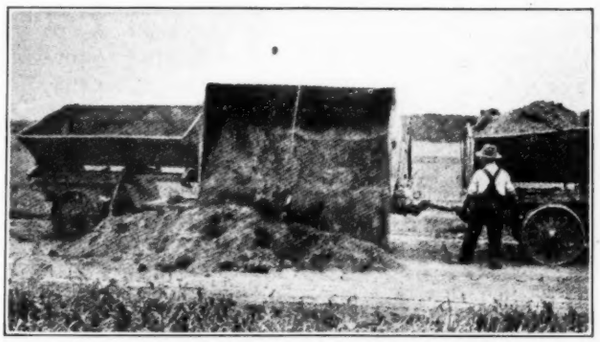
Equipment

The contractor's force consisted of one tractor and one horse drawn outfit, with the following equipment:

2 Foremen	2 Blade Graders
2 Stablemen	1 Holt Tractor (10 Ton)
1 Blacksmith	2 Elevator Grades
1 Engineer	1 Tractor 1 Horse Drawn
2 Plowholders	27 Teams
1 Machine Driver	2 Mormons
1 Timekeeper	20 Men
14 Wagons	

Use of Motor Trucks

When the work of graveling the road was started, the gravel was hauled in army trucks, allotted to the State by the Government. These trucks were equipped with



DUMPING GRAVEL ON THE FREMONT-CERESCO, NEBRASKA, ROAD.

dump bodies, and hauled an average of 2¼ cu. yds. per load. The gravel was excavated from a bank pit, with an auto crane, equipped with clam-shell bucket. Later it was deemed advisable to discontinue the trucks, and use Troy trailers in a train of from 8 to 10, capacity approximately

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with their present day vehicular traffic, demand constant inspection and immediate attention when the surface shows signs of wear. Efficient systems of highway patroling have resulted.

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460 E. Pearl Street

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4 yds. The size of the load was governed by the condition of the road, and the steepness or rutty condition of the surface. Trailers were purchased, and the work is being done with comparative ease and rapidity.

Gravel Spread in Two Courses

One of the most important facts developed during construction was that the gravel must be spread in two courses of 2 ins. each, thereby enabling the first course to rut into the surface of the road, and become thoroughly compacted before the second course was applied. By this method, a more compacted and smoother surface resulted than could possibly have been secured by applying one 4-in. course at a time.

Constant dragging is necessary with this type of surfacing, and especially during the time the road is compacting. An abundance of rain will also aid the process and insure a smoother surface. The traffic ruts in the gravel, but continues only for a short time, for as it dries the rutting ceases and the road surface commences to smooth out under the general traffic, and the care that is given it at this time, of dragging and blading. The traffic is as essential as the periodic dragging, and the one assists the other.

Not Merely a Surfacing Process

It must be remembered that this type of gravel road is not merely a surfacing process, for the earth road bed must be well compacted and thoroughly drained before the gravel is spread. Promiscuous spreading of gravel on roads that apparently have a good surface is not warranted. The crown should be 6 ins. with a 24-ft. roadway, and in such condition that it will support traffic. The gravel provides the wearing surface and in addition keeps the subgrade dry, as the gravel by reason of the clay and iron oxide contained in it, is more or less impervious to water, much more so than the best of well compacted earth road beds.

There are several gravel projects at present in Nebraska, located at Wood River, Grand Island and North Platte-Sutherland. If the latest request from the Federal Government is compiled with, it will mean that hereafter, projects will not be approved unless there is an adequate and substantial type of surfacing promised for every Federal Aid road in a reasonable time after the initial improvement of the project. In short, the time is coming when this State will of necessity, provide a substantial surface for the Federal roads, and in all probability, since there is an abundant supply of gravel in the State, a large share of these roads will be graveled.

At present this type of surfacing is being watched closely by engineers, road enthusiasts, and the general public, for it may yet prove to be Nebraska's cheapest and best type of surfacing for the State Highway System.

LOADING AND SCREENING WITH A SCOOP CONVEYOR

The accompanying illustration shows a novel Scoop Conveyor installation at the sand pit of Somers & Sons, Wyoming, Pa. Mr. Somers had been experiencing much trouble and expense in screening his sand and, being a resourceful man, it occurred to him that an arrangement could be made with his Scoop Conveyor so as to screen while loading. The arrangement illustrated was adopted. The screen was placed in the truck and supported by a pole and, on the edge of the truck, by a small block of wood.

The 24-ft. Scoop Conveyor was then placed so that the material, when discharged, would fall near the top of the

NOVEL SCOOP CONVEYOR INSTALLATION AT A SAND PIT.

screen. The screen being set at the proper angle the large lumps rolled off out of the truck while the fines fell through.

With this arrangement Mr. Somers is loading and screening tons of sand in 7 minutes. In addition to the money saved on the loading operation the additional revenue obtained by delivering screened sand made this an investment that soon paid for itself.

AUSTIN EXPANSION BENEFITS CONTRACTORS

Difficulty in obtaining necessary equipment last year interfered with the improvement plans of cities and counties everywhere. The concerns and individuals who are responsible for the conversion of huge appropriations for road building, irrigation projects, building excavations and kindred developments, needed a powerful ally in overcoming this obstacle.

To make its comprehensive line of paving, trench-digging and concrete-mixing machinery immediately available to contractors, thus assuring them that any contract-obligations they may assume will be fulfilled to the letter, the Austin Machinery Corporation reports the establishment of ten primary district offices and warehouses and upwards of fifty subsidiary offices and agencies throughout the United States.

It is the purpose of this corporation to place every contractor, city engineer, public works director and official, and other user of road-building and sewer and water-pipe trench-digging machinery in the United States in close proximity to a branch of the organization in charge of experienced representatives capable of rendering efficient service, to the end that they may order any required machines and parts with full assurance that they will be delivered at the stations nearest their first jobs on or before the date specified to begin operations.

The cities at which the district offices and warehouses are located were selected with a view of affording the most strategic positions from point of trunk-line shipment. Each warehouse carries a full stock of machines

and parts. Their large manufacturing plants are in full production. The needs of foreign countries, as well as domestic requirements, are provided for.

The organization plan by which this was accomplished was so comprehensive and so thoroughly worked out that all types of Austin machines soon will be available, on short notice, anywhere in the United States and in a large section of Canada.

The full significance of this achievement becomes apparent with a realization of the fact that the Austin Machinery Corporation is the largest manufacturer of the most comprehensive line of earth-moving and concrete-mixing and handling machinery in the world.

GREAT EXHIBITION OF HIGHWAY MACHINERY AND MATERIALS

Representatives of fifteen industries identified with highway construction held a meeting at The Automobile Club of America October 22, 1920, the purpose of the meeting being to complete the organization of an advisory committee of manufacturers to co-operate with the American Road Builders' Association in holding a great exposition of highway equipment and materials in connection with the Association's annual convention, which will be held at The Coliseum, Chicago, during the week of February 7, 1921.

The industries represented at the forthcoming exposition will include the sand and gravel industry; crushed stone; Portland cement; asphalt and oil; tar; granite block; paving brick; slag; road building machinery; quarrying machinery; excavating machinery; trucks, tractors and trailers; concrete mixers; engineering instruments and explosives. It was developed at the meeting that upwards of one billion dollars is annually available for highway and street work and that a genuine necessity exists for capacity production and distribution of highway materials and equipment.

An Executive Committee to represent the producers and manufacturers was appointed, consisting of J. E. Pennybacker, of The Asphalt Association; B. H. Wait, of the Portland Cement Association; W. T. Chollar, of the Lakewood Engineering Company; D. C. Fenner, of the International Motor Truck Company, and P. P. Sharples, of The Barrett Company. A Chicago Committee was also appointed, with S. F. Beatty, of the Austin-Western Road Machinery Company, as Chairman.

CONTRACTS AWARDED

ROADS AND STREETS.

Ark., Star City—General Constr. Co., Little Rock, Ark., awarded contract to construct 13 miles gravel road, at $325,000.

Ala., Decatur—A. B. Howard & Co., 148 Fourth Ave., N., Nashville, Tenn., awarded contract for grading, draining and surfacing 9.17 mi. State Trunk Rd.—Albany to Hartsells—at $61,742.

Ala., Florence—Wm. T. Taylor Constr. Co., Sylacauga, Ala., awarded contract by State Hwy. Comm., Montgomery, to construct 12 miles of road in Lauderdale Co., at $156,885.

Ariz., Phoenix—State Hwy. Dept., Phoenix, awarded contract to M. Ryan, 935 Bway., San Diego, Cal., at $143,112, for gravel surfacing 8.6645 miles Sec. D, Florence Superior Hwy., F. A. Proj. 23, involving 46,430 cu. yds. unclassified excav. in rdway, cost $1.65 per cu. yd., 20,760 unclassified borrow excav., etc., etc., at total cost of $177,031.

Ariz., Florence—Jack Davey, Superior, awarded contract for constr. of 10,058 sq. yds. concrete pavement thru town of Ray, at $52,834.

Cal., Fresno—California Constr. Co. awarded contr. for paving with asph. conc., Route 3, Secs. A and B Madera Avenue, 7.223 miles, at $174,142.

Cal., Fresno—California Constr. Co. awarded contract for paving Sec. A, Routes 16, 22, 23, 24, 29 and 30, and part of Route 18, Sec. A and Route 20, Sec. B county hwy. (Fowler-Selma-Kingsburg Rd.) at $507,572.

Cal., San Francisco—Schultz Constr. Co. awarded contract for Market Street extension work at $97,192. Wk. includes grading, laying sewer and bldg. conc. retaining walls.

Cal., Stockton—C. Moreing, Stockton, awarded contrs. for grading Hammer Lane and Upper Copperopolis Rd., at $48,075 and $63,919, respectively; Waterloo Rd., to F. E. Brooks, Stockton, at $30,096.

Cal., Stockton—J. E. Johnston, Tracy, awarded contr. for grading and paving Walnut Street and others, with bitum. pavement and constructing cement curb, walks and gutters, at $56,954.

Ga., Decatur—Kreis & Wardrep, Knoxville, Tenn., awarded contr. to construct 1.913 miles National Hwy. betw. Decatur and Scottdale, at $750,000.

Ga., Rome—J. W. Stapp Constr. Co., Louisville, Ala., awarded contr. to construct 7 miles soil-surfaced roadway, $65,000 available.

Ill., Murphysboro—Bius & Olsen, St. Joseph, Mo., awarded contr. for constr. of 2 sections from Anna to Ullin, at $223,000; Ullin to Pulaski, at $71,920.

Ill., Springfield—Following contracts let for road construction: Goggin Constr. Co., Arcola, Ill., contr. for Sec. 2A, Henry Co., at $63,552; E. A. Lord Constr. Co., Monmouth, Ill., contr. for project 20, Sec. 6A, 7A, 8A, Henry and Bureau Cos., at $58,900; Gund-Graham Co., Freeport, Ill., contr. for project 20, Sect. 10A and 11A, Henry and Bureau Cos., at $19,906; Keokuk County & Constr. Co., Keokuk, Iowa, project 21, Sec. 2A, Warren Co., at $22,997; Shidler Constr. and Material Co., Kankakee, Ill., contr. for project 22, Sec. 1A, Kankakee Co., at $7,450; Hamilton Bros., Carbondale, Ill., project 14, Sec. 3A, Jackson Co., at $33,130; A. M. Woolan, 607 Wainwright Bldg., St. Louis, Mo., for project 14, Sec. 23A. and project 9W, Fayette County, at $171,400.

Ill., Springfield—Following contracts let by Dept. Pub. Wks.: Buis & Olson, St. Joseph, Mo., grading Sec. 13A Union Co. and Sec. 14A, Union and Pulaski Cos., both Fed. Aid Proj. 14, $223,000; Sec. 15A, F. A. Proj. 14, Pulaski Co., $71,920; Cameron, Joyce & Co., Keokuk, Iowa, Sec. 16A, F. A. Proj. 14, Pulaski Co., $70,628; M. Hayes & Son, Janesville, Wis., Sec. 2A, F. A. Proj. 18, Champaign Co., $11,716.

Ind., Ft. Wayne—J. C. O'Conner & Son, 2440 Hoagland Ave., awarded contract for grading, draining and paving 7,837 ft. Pontiac St. and Beuter Rd., 18-24 ft. wide, concrete, at $144,039; Grace Constr. and Supply Co., 221 Utility Bldg., awarded contracts for grading, draining, curbing and paving 356 ft. Cherry St., 26 ft. wide, 588 ft. Comparet St., 26 ft. wide, 455 ft. Howell St., 24 ft. wide and 942 ft. State Blvd., 24 ft. wide, at $38,929.

Ind., Indianapolis—Sheehan Constr. Co. awarded contr. for impvt. of Northwestern Ave. Rd., at $154,000.

Ia., Clinton—Koss Constr. Co., 2818 5th St., Des Moines, awarded contract for paving 18 miles of Lincoln Hwy., at $47,900 per mile.

Ky., Henderson—Hopkins Co. Constr. & Engr. Co., Madisonville, Ky., awarded contract to construct 4½ miles of road, at $36,023; also contract for 9 mi. Madisonville-Hopkins Rd., at $96,161; J. C. Williams, Winchester, Ky., awarded contract for 10 mile Madisonville-Dixon Rd., at $136,676.

Ky., Whitesburg—Letcher Co. Commrs. let contracts to construct 4 mi. earth rd., Whitesburg to Hindman Hwy., 100,000 cu. yds. excav., at $80,000, to Hale & Hall, Whitesburg, Sec. 1; T. R. Rainero, Seco, Ky., Sec. 2.

La., Covington—Bonnabel Constr. Co. awarded contract for constr. of state highway betw. Slidell and Pearl River, at $83,239.

La., Vidalia—Junkins Bros. & Gregory awarded contract to construct 12 miles of road, at $98,342.

Md., Leonardtown—Ernest H. Schmidt, 2226 Garrison Ave., Balitmore, awarded contract to construct 5 miles State Hwy. from Morganza toward Colton; gravel; St. Marys Co., Contr. SM-14, at $70,429.

Mass., Boston—J. W. O'Connell, Radcliffe Rd., Brighton, awarded contract by Dept. Pub. Wks. for paving Mt. Vernon St., asphalt, at abt. $25,000; B. E. Grant, 27 School St., awarded contract by City for relaying granite blk. pavement on Friend, Richmond and Portland Sts., at $87,300; M. De Matteo, 154 Dudley St., Roslindale, awarded contr. for paving with asph. Arbutus St., Dorchester, at $13,100.

Mass., Brighton P. O., Boston—Simpson Bros., Corp., 77 Summer St., Boston, awarded contract for paving Market and Arlington Sts., asph., at $97,742.

Miss., Natchez—F. D. Harvey & Co., Memphis, Tenn., awarded contr. for Adams Link of Prentiss Hwy. Est. cost, $248,000.

N. J., Newark—Essex County let contracts for impvt. of Franklin Ave., Belleville and Nutley, to Osborn & Marsellis, Belleville Ave., Montclair, at $41,344 and $21,406 respectively; John and Rutgers Sts., Belleville, Belleville Ave., Glen Ridge and Holler Pkway, Newark, to Northern Constr. Co., 75 Montgomery St., Jersey City, at $152,000, $27,663, $155,067 and $30,130 respectively; Chancellor Ave., in So. Orange and Irvington to Standard Bitulithic Co., 50 Church St., New York City, at $15,700 and $204,480 respectively.

N. Y., Brooklyn—Boro. Pres. Riegelmann let contract for regulating & repaving Kingsland Ave. to Grocco Bros., 172 Russell St., at $29,674; 7th Ave. to Brooklyn Alcatraz Asphalt Co., 407 Hamilton Ave., at $7,463; 58th St. to T. E. McCormick, 810 Lincoln Rd., Flatbush, at $20,353; restoring & repairing where directed, to Sicilian Asphalt Paving Co., 41 Park Row, N. Y. City, at $173,740.

N. Y., St. George, S. I.—C. D. Van Name, Pres. Richmond Boro., let following contracts: repaving with conc. Arthur Kill Rd., Fosters to Woodrows Rd., and from Sharrots to Foster Rds., to W. P. McDonald, Port Richmond, at $163,120 and $165,071 respectively; from Woodrow to Richmond Rd., to J. Donovan, 2205 Richmond Ter., Pt. Richmond, at $164,042; from Bentley St. to Sharrots Rd., to J. Johnson Son, West New Brighton, at $214,487.

N. C., Franklin—Wright & Nave, Asheville, N. C., awarded contract to construct 20.9 miles Three States Natl. Forest Rd., graded, 16 ft. wide, project within Natajala Forest, Rabun, Ga., Macon, N. C., and Oconee, S. C., Counties. $216,000 available.

N. C., Raleigh—Southern Dray Co., Asheville, awarded contract for bldg. 7 miles State Aid Project 100A and 7 miles Proj. 100B, Western N. C. Hwy., Avery Co., waterbound macadam, and 2½ miles gravel road, Madison Co., at $158,000, $124,000 and $75,000 respectively.

O., Cleveland—Gould & Maybock, 823 E. 150th St., awarded contr. for grading, draining and paving E. 14th St., St. Clair to Aspinwall Aves., brick, at $88,513.

Okla., Lawton—Allen & Harrison, Henryetta, awarded contract for rd. work, F. A. Proj. 22, at $73,481.

Ore., Enterprise—Northern Pacific Constr. Co. awarded contract for 4 miles of grading at $326,000.

Ore., Portland—Scandia Shipbldg. Co., Marshfield, awarded contr. for paving Pacific Hwy. betw. Multnomah Co. line and west end of suspension bridge at Oregon City, approx. 6.5 miles, at $220,712. Rd. will be paved with concrete; Washburn & Hall, Broadway Bldg., Portland, awarded contract for road—Wren to Blodgett—Cornwallis-Portland Hwy., at $27,917; J. W. Hilstrom, contr. for Rocking Brush Creek, Hubbard-Creek sect. Coast Hwy., at $25,-900; Porter & Connelly, Railway Exch. Bldg., Portland, awarded contract for grading and rocking Lawen to Crane Rd., Harney Co., at $147,365.

Ore., Salem—Following contracts let by State Hwy. Comm.: gravel surfacing 4.94 mi. McMinnville-West Dayton Sec., West Side Hwy., Yamhill Co., to E. A. Palmer, Lafayette, at $24,395; 9.36 mi. Butte Creek Sec. Jno. Day River Hwy., Wheeler Co., to Blake-Compton Co., McMinnville, at $74,-160; 4.55 mi. Cole Bridge-Danby Ranch Sect. John Day River Hwy., Grant Co., to J. Ross, Prairie City, at $26,960; grading and gravel surfacing 7.86 mi. Haines-North Powder Sec. Old Oregon Trail Hwy., Baker Co., to Oxman & Harrington, Baker, at $99,340.

Pa., Beaver Falls—H. Kirker Co., local, award. contr. for paving First Ave., 8th Ave., 9th, 14th, 15th, 17th Sts., at $170,000.

Pa., Harrisburg—S. Gamble, Carnegie, Pa., awarded contract for bldg. 34,837 ft. one-course rein. conc. roadway on Route 115, Washington Co., at $475,646.

Pa., Philadelphia—Contracts for grading and paving streets costing about $700,000 awarded by Director F. H. Caven. Barber Asphalt Co. and Eastern Paving Co. awarded the bulk of the contracts, although Mack Pavg. & Constr. Co. received one contract for $6,300. Grading work will cover abt. 2 miles of streets, while the paving will take care of approx. 4½ miles (67 blocks).

S. C., Anderson—Phillips & Newell awarded contract by Anderson Co. Hwy. Comm. to construct 8.414 miles Belton-Anderson Rd.; bridges; 54,000 cu. yds. grading; 35,000 cu. yds. top-soil. $80,000 available.

Tex., Highland Park (P. O. Dallas)—Uvalde Paving Co., Dallas, award. contract to pave Lexington and Gillon Aves. $110,-000 available.

Tex., Paris—Smith Bros. & Healy Constr. Co., Dallas, awarded contr. to grade 23 miles Hwy. No. 5, and 25 miles Hwy. No. 19, at $132,000; A. D. McLain Co., Houston awarded contract for conc. draing. structs. at $135,000.

Tex., San Antonio—Southwest Bitulithic Co., 711 Gunter Bldg., awarded contract to pave Camp, Burleson, Cherry, Travis and other streets and avenues, at $289,800.

Tex., Ft. Worth—W. P. McCoy, Ft. Worth, awarded contract for grading and constructing draing. structs. on 8.74 mi. White Settlement Rd., at $60,700; D. H. Purvis, Ft. Worth, Tex., awarded contract for grading 1.76 mi. and constructing draing. structs. on Arlington Grapevine Rd., at $45,984.

Va., Richmond—Atlantic Bitulithic Co. awarded contract for paving at $88,036.

W. Va., Beckley—Sutton Constr. Co., Pikesville, Ky., awarded contr. to grade and drain 4¼ miles Jarrolds Valley-Concord Rd. $100,000 available.

SEWERAGE AND SEWAGE TREATMENT.

Cal., Fullerton—Wm. Ledbetter & Co., Pacific Electric Bldg., Los Angeles, awarded contracts for constructing sludge tank at $16,370 and constructing screening plant at Fullerton Sewer Farm, at $1,004. This contractor also bid $1.85 for 760 ft. 15-in. vitr. pipe, but City decided to put in pipe with its own force.

Cal., Los Angeles—W. A. Frick, 440 S. Daly St., L. A., awarded contr. for constr. of san. sewers on Bway., 6th, Olive and 7th Sts., at $158,776.

Cal., San Leandro—Jas. Tobin, Oakland, awarded contract to constr. storm sewer on Alvarado St.—Saunders St. to San Leandro Crk.—at $16,412; also contr. to construct sewer on Elsie Ave., at $1,096.

Ont., Toronto—R. C. Harris, Works' Commr., awarded contr. for reconst. of sewer on York St., Front to King Sts., at $16,151.

Fla., Bayboro—R. L. West, St. Petersburg Constr. Co., awarded contr. for installing sewage disp. tanks in Bayboro, at $48,000.

Ill., Quincy—Henry Rees & Son awarded contr. for construction of local impvt. known as South End Sewer Dist., at $28,-965; also local impvt. known as N. 12th St. Sewer Dist., at $18,124.

Ind., Indianapolis—Columbia Constr. Co., Indianapolis, awarded contract for impvt. of sewers in and along Buckingham Dr., at $9,500.

Ind., Worthington—D. H. Bond, Vincennes, Ind., award. contr. for san. sewer system, at $109,200.

Ia., Davenport—Independent Constr. Co., 304 Lane Bldg., awarded contr. for sewers in Westholme, 2nd, 3rd, 4th Addns., at $53,-007; A. Kahles, City, award. contr. for constr. of sewer in Elm St., at $1,523.

Ia., Sioux City—J. F. Devlin, local, awarded contract for san. sewers, Lovell and Pavania St; 2,330 lin. ft. 8-in. vitr. clay pipe, $2.38 per ft.; 8 stand. brk. m.h., $114 each; 48 ft. c.i. pipe, $8; J. M. Lewis, 625 5th St., awarded contr. for storm water sewers, 3rd St., Virginia to Court Sts.; 396 ft. 24-in. vitr. clay or conc. pipe; $7.65 ft.; 1,200 ft. 12-in. clay or conc. pipe, $3.32 per line. ft.; Todd Plmg Co., 20 W. 3rd St., awarded contr. for sewer and water connects. in Jones St.—21st to 28th Sts.; 39 sewer connects., $2.90 per lin. ft.; 21 water connects., $85 each complete; 40% bond req.; also contr. for sewer and water connects. in 17th—Court to Cliff Sts., Chase, Taylor and Easleys Addns.; 15 sewer connects., $2.85 per lin. ft.; 6 water connects., $85 each complete; also contr. for sewer and water connects. from 32nd to 36th, Pierce's Addn.; 11 sewer connects., $2.95 per lin. ft.; 16 water connects. $85 each complete.

Mass., Boston—A. Barruffaldi awarded contr. for bldg. sewerage works in Farragut Rd. extension, S. Boston, at $37,397; Jos. Todesca, contract for sewerage works in Cambridge St., betw. Hano and Wilton Sts., Brighton, at $3,126; Timothy Coughlin awarded contract for sewerage works in Amory Ave., Roxbury, at $5,760.

Mass., Boston—Andrews Constr. Co. awarded contract for cleaning pipe and brk. sewers in Cambridge St., under Bost. & Mo. R. R. trks., at E. Somerville Sta., etc.; Samuel J. Tomasello awarded contr. for bldg. sewerage works in Alger St., Dorchester Ave., abt. 540 ft. westerly, So. Boston, at $13,125; Geo. J. Regan awarded contr. for sewerage works in Roanoke Rd., Hyde Park, at $1,158; J. Guarino & Co. awarded contr. for sewerage works in Itasca St., Dorchester, at $10,103.

Mass., Boston—Wm. Barrett & Co. awarded contr. for bldg. catch basins and minor drains, at $13,364.

Mich., Pontiac—Misak Kevorkian awarded contract for surf. drain in Perkins St., Whittemore to Cottage, and in Cottage and Willard west from Perkins St., at $4,872.

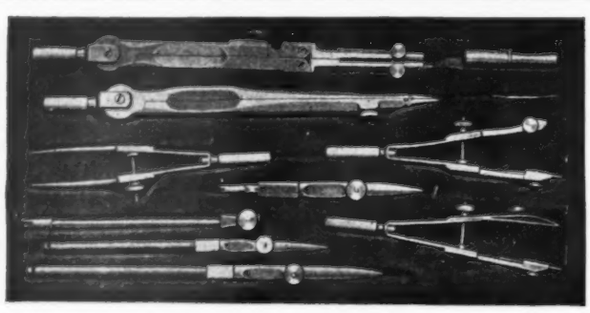
Minn., Cloquet—Pastoret Constr. Co., 510 Lyceum Bldg., Duluth, awarded contract for sewer and water extensions in H Ave., Walnut St. to Laurel St., So. to Carlton Ave. West, at $18,544.

Mo., Joplin—Jno. L. Zeidler, St. Joseph, Mo., awarded contract for sewer system, at $64,650.

Mo., St. Joseph—Thomas & Howard awarded contract for constr. of main sewer in Arthur's branch, at $8,549.

N. J., Paterson—Toriello & Sansome, Hackensack, awarded contr. for bldg. branch intercepting sewer at Lowe Street, Paterson, at $20,000.

N. Y., Brooklyn—Tomasetti Co. awarded contract for bldg. sewer in New Utrecht Ave. ,at .9598% of engineer's estimate of $26,433; E. 24th St., from Ave. N to Ave. O and from Ave. L to Ave. M; also in 82nd St., to A. Ferris, 94% of engineer's ests. of $4,435, $5,400 and $5,217, respectively; Warehouse Ave., to Murphy Bros., 122.8% of est. of $8,360.



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N. C., Gastonia—B. W. Harris, Durham, awarded contr. for constr. of sewage disp. plant on city's farm south of Gastonia, at $60,000.

N. C., New Holland—H. E. Miller Constr. Co., Columbus. O., awarded contr. by N. C. Farms Co., New Holland, to install sewer, water and electric lighting systems, at abt. $50,000.

O., Akron—E. & W. McShaffrey Co. awarded contr. for sewer in S. Main St., Emrling, Sweitzer, Brighton, Marcey, Curtis and Leora Sts., at $40,668; J. J. Donnely and Wm. Lehmann awarded contract for bldg. Willow Run sewer to drain territory in vicinity of Perkins Hill and East Ave., at $372,062.

O., Cleveland—Amato Constr. Co., 345 The Arcade, awarded contr. for bldg. sewer in Luke Rd. extension, involving 1,450 ft. C brick pipe, at $34,393; A. Hosine, 635 Bradley Court, awarded contract for bldg. sewers and water mains in Yorkshire Heights allotment, at $33,503.

Okla., Walters—N. S. Sherman Mach. & Iron Wks., Okla City, awarded contract for extension of san. sewer and water systems, at $86,000.

Pa., Harrisburg—Henry Opperman awarded contr. for laying Elder St. sewer, at $13,370.

Pa., Philadelphia—Adolph Jafolla awarded contr. for constr. of Rich Run main sewer on Ontalauna St., at $190,000.

Pa., Williamsport—R. J. DeLong, Williamsport, awarded contract for constr. of 1,380 ft. 8-in. t. c. house sewer, appurts., etc., on Boyd, Penn. and Seth Sts., at $6,717.

Tex., Dallas—Cramer & Cullom awarded contr. to construct storm sewers in Lamar St., from Young to Powhatan Sts., and in Cadiz St. from Mill Crk. to Austin St., at $29,665.

Wn., Seattle—Fiorito Bros. awarded contract for clay pipe sewers on Shilshole Ave., et al., at $73,483; Coluccio & Erickson contr. for clay pipe sewers on King St., at $20,163.

Wis., Amery.—Rohr & Pratt, Pipestone, Minn., awarded contract for bldg. sanitary and storm sewers in various streets, at $32,992.

Wyo., Newcastle—Hyrtle Fryer awarded contr. for sewerage system, at $6,795.

WATER SUPPLY AND PURIFICATION.

Que., Montreal—Atlas Constr. Co., 37 Belmont St., awarded contr. by Administration Comn. for bldg. 5-ft. conduit, 196 ft. long, from collecting well at water works to new electric pumps, at about $24,000.

N. B., St. John—Canada Lock Joint Co., Prince William St., awarded contract for extending water works system, involving 36 in. water main to Spruce Lake, at about $357,000.

Ont., Toronto—Contracts for water mains in county of York awarded as follows: Humber Crest Blvd. and St. Marks Rd., to G. Thompson, at $2,167; Bude St., G. Thompson, $1,362; Spears, Leigh and Mahoney Sts., A. Cavotti, $2,291; Cataract, Daisy, Dundas and Chenne Sts., G. Thompson, $4,166; Astoria, Bushey and Graham Sts., G. Thompson, at $1,744; A. Cavotti, 257 Euclid Ave., awarded contr. for construction of 12-in. water mains in nine streets for York Twp., at $22,975; Grant Contg. Co., 50 Front St. E., awarded contract for work in one street at $5,805.

Ill., Rockford—R. P. Beckstrom & Co., 208 Trust Bld., awarded contract for bldg. new pumping station, at $88,122.

Ia., Cherokee—State Bd. Control, Des Moines, let contr. for laying 5,000 ft. 8-in. pipe to Sieg Constr. Co., Waterloo; bldg. pump house, pump pit and reservoir to Rhodes & Christianson, Guthrie Center; furnishing machy. to Fairbanks-Morse Co., 900 S. Wabash Ave., Chicago. Total about $78,500.

Ia., Doon—Ralph Cox, Webster City, awarded contract for extensions to water mains, at $13,190.

Mass., Boston—Westinghouse Elec. & Mfg. Co., 10 High St., awarded contr. for furnishing and erecting two pumping plants and high pressure fire service, at $174,469.

Mass., Boston—National Water Main Cleaning Co. award. contr. for cleaning water pipes in 2nd, D and L Sts., S. Boston, and Pearl St., city proper, at $3,312; Pitometer Co., New York City, award. contr. for waste water survey of entire So. Boston distribution sys. and portion of South End distribution sys. bounded by N. Y., N. Haven & Hartford R. R., Northampton St. and South Bay, at $10,000.

Mass., Boston—Jas. Barletta awarded contr. for laying and relaying water pipes in Ashland St., Florence, Poplar and Wachusett Sts., W. Roxbury, at $9,007; Jno. Williams, contr. for laying and relaying water pipes in Washington, Groton, Laconia and Acton Sts., city proper, at $5,420.

Mo., Fayette—McGraw & Frazier, Fayette, award. contr. for following work: constr. earth dam and 8-in. supply line; 30,000 cu. yds. earth fill; 3,000 sq. yds. riprap; rein. conc. intake; riprapped spillway, cleanout; sluice gates; track rack; 14,000 ft. 8-in. wood pipe. Total cost $62,000.

Minn., Duluth—National Cast Iron Pipe Co. awarded contr. for furnishing cast iron pipe, at $23,700.

Neb., O'Neill—J. Danielson, Omaha, awarded contract for laying water mains in various streets, to cost plus percentage basis; furnishing 150,000 gal. tank and tower to Omaha Struct. Steel Co., 48th & Leavenworth Sts., Omaha, at about $20,500.

N. C., New Holland—H. E. Miller Contg. Co., Columbus, O., awarded contract to install water, sewer and electric light'g. systems, at abt. $50,000. Contr. awarded by New Holland-No. Car. Farms Co., New Holland.

O., Akron—N. Y. Continental Jewell Filtr. Co. awarded contr. for construction of 10 new filter beds at Kent pumping station, at $127,913.

O., Cleveland—A. Hosine, 635 Bradley Court, awarded contract for laying sewers and water mains in Yorkshire Heights allotment, at $33,503.

O., Grafton—Village let contracts for bldg. 4-8 in. cast iron water mains to D. Pfahl Co., Guardian Bldg., Cleveland; for 2-sty., 20x20 ft., conc. pump house, to Dobson-Maines Co., Pittsburgh, Pa.; 2 deep well pumps, to Cleveland Pump & Supply Co., Guardian Bldg., Cleveland; awarded contract for sewerage system to T. Tripoliti, Lorain, at total cost of $100,000.

O., Maple Heights (Cleveland)—A. Lanese Co., Columbia Bldg., Cleveland, awarded contract for laying 6,040 ft. 6-10 in. cast iron water mains in various streets, at about $54,000.

Okla., Walters—N. S. Sherman Mach. & Iron Wks., Okla. City, awarded general contract for extension of water and san. sewer systems, at $86,000; constructing storage reservoir for water plant; laying 120,009 ft. additional mains.

S. C., Rock Hill—Tucker & Laxton, Charlotte, awarded contr. for putting in $150,000 worth of water and sewer line extensions here.

Tex., Wichita Falls—City will improve water works system by day labor under supervision of J. A. Donald, Act'g. City Engr.

Va., Norfolk—Sanford & Brooks Co., Commerce and Water Sts., Baltimore, Md., awarded contract to construct dam, spillway and roads, at $200,000. Take Prince reservoir at $573,456.

Wn., Bremerton—F. N. Badolato, 509 Arctic Bldg., Seattle, award. contr. for installation of one of largest pieces of water main work ever let in Bremerton. Project consists of over 20,000 ft. 6-in. wood stave pipe, 1,700 ft. cast iron pipe, together with hydrants, valves, gates, etc. Approx. cost $53,000.

PROSPECTIVE WORK

ROADS AND STREETS.

Ala., Geneva—Geneva County Commrs. considering surfacing 25-mile road from Geneva to Houston Co. line; sand and clay. $170,068.

Ala., Montgomery—Elmore Co. road project, submitted by State to Secy. of Agricult., approved by Bureau of Pub. Rds. for constr. of rd. ½-mi. south of Judkins Ferry, running 6.95 mi. in length to Wetumpka. Rds. to be surfaced at est. cost of $203,851.

Cal., Avalon—Petitions for street impvts. to cost $139,877, signed by property owners of Catalina Island. These include paving of Crescent Ave., Marilla, Whittley, Metropole, Sumner, Catalina, Claressa, Beacon, Olive, San Clemente and Vieudelou Aves. A. B. Waddingham, City Engr. and City Mgr.

Cal., Downieville—The 4-mi. unit of state hwy. lateral betw. Downieville and Goodyr. Bar, will be constructed at once.

Cal., El Centro—Street impvts. to cost betw. $400,000 and $500,000 are being considered. Council has instructed City Engr. Knights to hasten prelim. proceedings. Streets to be paved are as follows: 4th from State to city limits; all streets running east and west from south city limits to north of Euclid Ave.; belt line across railway trk. and back, and portions of 8th and 9th Sts.

Cal., Pomona—Proceedings under way for impvt. of abt. half a mile of 20-ft. alleys in business district. They will be paved with 1:2:4 concrete, 5-in. thick, oil (95% asph.) and screenings surface ¾-in. thick. Clarence E. Bayley, City Engr.

Cal., Riverside—Co. Engr. A. C. Fulmor submitted to Supvrs. ests. of cost of roads planned in Impvt. Dist. No. 7, Mecca Section. There will be 18 miles of highway which, paved with conc. reinforced with wire mesh, will cost abt. $333,000. Macadam paving est. to cost $250,000.

Cal., Riverside—Council considering impvt. of 4 mi. double driveway on Magnolia Ave. with conc. rdbed 6-in. in thickness. Est. cost $160,000 or more.

Cal., Sacramento—Calif. Hwy. Comm. expects to call for bids in near future for constructing 2 sections of Coalinga pass lateral. One of these sections, west of Lemoore, is 14 miles; the other extends from Oil King sch. house to Huron, 9 miles.

Colo., Colo. Springs—City council has appropriated $30,500 for repair of streets here. Road expndts. involving outlay of abt. $20,000 approved by U. S. Bureau of Pub. Rds. for reconstr. of first class road from Phantom Canon Rd. thru Victor to Cripple Creek. E. Nicholas, Manitou, Chrm. State Hwy. Comm.

Colo., Denver—Prominent citizens of Englewood and Denver launching campaign advocating that 20 blocks of paving be done by city at once; work to be done on S. Bway., Exposition Ave. to Yale Ave.

Conn., New Haven—City plans to pave various streets. Abt. $200,000. F. L. Ford, City Engr.

Fla., Miami—$350,000 bonds voted by Dade Co. Commrs. for constr. of roads.

Fla., Pensacola—Escambia Co. Commrs. considering constr. of 102 mi. of paved roads; concrete; $2,000,000 bonds voted

Ill., Chicago—Public Utilities Commission has ordered Chicago & West Towns R. R. Co to pave Chicago and Harlem Aves., Oak Park, and to rehabilitate their equipt. Work will entail expndt. of $189,800.

Ill., Rock Island—Council has engaged Monroe L. Patzig, Cons. Engr., Des Moines, to have charge of paving to be done in the Hill district. Grading tests will also be made by Mr. Patzig.

Ind., E. Chicago—City Engr. instructed to prepare plans for paving White Oak Ave., the dividing line betw. Hammond and E. Chicago.

Ind., Montpelier—Co. Commrs. and Rd. Supt. Frank Jones have decided to improve three streets here. Warren Ave. and street from steel mill to school house are to be regraveled; Green St. will be patched with stone. Ben Swoveland, Dist. No. 6, will have charge of Warren Ave. work; Marshall Dragoo will have supervision of the other impvts.

Kans., Concordia—Cloud County has plans prepared for grading, paving and bldg. bridges and culverts on 40 miles of Midland Trail, 18 ft. wide. Tuttle, Ayres & Woodward, Reliance Bldg., Kans. City, Mo., Engrs.

Ky., Covington—City plans election to vote on $70,000 bonds to resurface 15 blocks Scott St.—6th to Sterret Ave.; $30,000 bonds for 5 blks. Main St.—4th to Pike; $50,000 bonds to improve 16 blks. Decoursey Ave., Latonia—32nd to 45th Sts.

Me., Augusta—Chamber of Commerce approved rd. impvt. plan calling for resurfacing 26 miles road in Augusta District.

Mass., Gardner—Town contemplates bldg. conc. rd. on Main St.—W. Gardner Sq. to Union Sq. Abt. $75,000. Sweet & Kendall, Gardner, Engrs.

Mich., Grand Rapids—City Mgr. Locke has submitted approx. est. of cost of widening and improving Fulton Street with brick on concrete base—West Park to Barclay Aves. Est. cost $233,200.

Minn., Minneapolis—Bd. Park Commrs. considering sale of $203,000 worth of bonds for paving work. Projects are paving of Stinson Blvd. in district of new Northwest terminal from E. Hennepin Ave. to Broad-

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The Texas Co.
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East Iron & Machine Co., The
Warren Bros. Co.

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Barber Asphalt Paving Co.
Warren Bros. Co.

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Duplex Truck Co.
Federal Motor Truck Co.
Garford Co., The
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Packard Motor Car Co.
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Pawling and Harnischfeger.

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Barber Asphalt Paving Co.

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Koehring Machine Co.

Bars, Reinforcing.
Truscon Steel Co.

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Barber Asphalt Paving Co.

Binders, Road.
Barber Asphalt Paving Co.
Barrett Co., The
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Standard Oil Co. (Indiana)
Uvalde Asphalt Paving Co.
Warren Bros. Co.

Bitulithic Pavements.
Warren Bros. Co.

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Braces, Extension.
Kalamazoo Fdy. & Machine Co.

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Olsen & Co., Tinius.

Brick-Testing Machinery.
Tinius Olsen Testing Mach. Co.

Bridges.
Lewis-Hall Iron Works.

Buckets, Dredging, Excavating and Sewer.
Pawling and Harnischfeger.

Buckets, Dumping.
Pawling and Harnischfeger.

Buckets, Grab.
Mead-Morrison Mfg. Co.

Cableway Accessories.
Sauerman Bros.

Cableway Excavators.
Sauerman Bros.

Calculators.
Kolesch & Co.

Car Pullers, Electric.
Mead-Morrison Mfg. Co.

Car Unloaders.
Austin Machinery Corporation.
Heltzel Steel Form & Iron Co.

Castings.
American Cast Iron Pipe Co.
Flower Valve Mfg. Co.
U. S. Cast Iron Pipe & Fdy. Co.

Cast Iron Pipe.
American Cast Iron Pipe Co.
Cast Iron Pipe Publicity Bureau
Crane Co.
U. S. Cast Iron Pipe & Fdy. Co.

Catchbasins.
Dee Co., Wm. E.
Madison Foundry Co.

Cement, Portland.
Portland Cement Association.

Cement Testing.
Kirschbaum, Lester.

Cement Testing Machinery.
Tinius Olsen Testing Mach. Co.

Centrifugal Pumps.
De Laval Steam Turbine Co.

Chimneys, Concrete.
Truscon Steel Co.

Chimneys, Steel.
Lewis-Hall Iron Works.

Chloride of Lime.
Pennsylvania Salt Mfg. Co.

Chutes, Concrete.
Heltzel Steel Form & Iron Co.

Concrete Mixers.
Austin Machinery Corporation.
Koehring Machine Co.
Smith Co., T. L. The.

Concrete, Reinforcement.
American Steel & Wire Company
Truscon Steel Co.

Concrete Sewer Pipe.
De Smet Quarts Tile Co.

Concrete, Tanks.
Mensch, L. J.

Concrete Tile.
De Smet Quarts Tile Co.

Conduits.
Cannelton Sewer Pipe Co.
Philip Carey Co., The.
Truscon Steel Co.

Conduit Rods.
Stewart, W. H.

Conduits, Wood, Creosoted.
Republic Creosoting Co.

Consulting Engineers.
Alvord, John W.
Artingstall, Wm.
Brossmann, Chas.
Burd & Giffels.
City Wastes Disposal Co.
Dow & Smith
Flood, Walter H., & Co.
Samuel A. Greeley
Howard, J. W.
Jones, Sam L.
Kirchoffer, W. G.
Kirschbraun, Lester.
Potter, Alexander
Shields, W. S.
Van Trump, Isaac.

Contractors.
City Wastes Disposal Co.
Sullivan, Long & Hagerty
Warren Bros. Co.

Contractors' Tools and Machinery.
Austin Machinery Corporation.
Austin-Western Co., Ltd., The
Barber Asphalt Paving Co.
Good Roads Machinery Co., Inc.
Koehring Machine Co.
Littleford Bros.
Smith Co., T. L. The.

Contractors' Wagons.
Austin Machinery Corporation.
Austin-Western Co., Ltd., The

Conveying Machinery.
Mead-Morrison Mfg. Co.
Pawling & Harnischfeger.
Portable Machinery Co., Inc.

Cranes and Hoists.
Austin Machinery Corporation.
Heltzel Steel Form & Iron Co.
Pawling and Harnischfeger.

Creosote.
The Barrett Co.
Republic Creosoting Co.

Creosoted Wood Block.
(Factory Floors, Bridge Floors)
Republic Creosoting Co.

Crushers, Rock and Ore.
Austin-Western Road Machinery Co., The
Good Roads Machinery Co., Inc.

Crushed Stone.
Cleveland Stone Co., The

Culvert Molds.
Austin-Western Co., Ltd., The
Storms Mfg. Co.

Culvert Pipe, Cast Iron.
American Cast Iron Pipe Co.
Cast Iron Pipe Publicity Bureau

Culvert Pipe, Vitrified.
Cannelton Sewer Pipe Co.
Dee Clay Mfg. Co., Wm. E.

Culverts.
Truscon Steel Co.

Curb and Gutter Forms.
Heltzel Steel Form & Iron Co.
Truscon Steel Co.

Curb Bar.
Truscon Steel Co.

Curbing, Sandstone.
Cleveland Stone Co., The

Direct Oxidation Process.
Direct Oxidation Process Corp.

Drag-Line Excavators.
Austin Machinery Corporation.
Pawling and Harnischfeger.

Drag Scrapers.
Austin-Western Road Machinery Co.

Drain Tile.
Dee Clay Mfg. Co., W. E.

Dryers.
Cummer & Son Co., The F. D.

Dump Cars.
Austin-Western Road Machinery Co., The

Dump Wagons.
Austin-Western Road Machinery Co., The

Dust Laying Compound.
Barber Asphalt Paving Co.
The Barrett Co.
Sinclair Refining Co.
Standard Oil Co. (Indiana)
The Texas Co.

Edge Protector.
Truscon Steel Co.

Elastite.
Philip Carey Co., The.

Electrical Wires & Cables.
American Steel & Wire Company

Elevating Graders.
Austin-Western Road Machinery Co.

Elevators.
C. H. & E. Mfg. Co.

Engineering Instruments.
Kolesch & Co.
Lufkin Rule Co., The

Engines.
C. H. & E. Mfg. Co.

Excavating Machinery.
F. C. Austin Machinery Co.
Pawling and Harnischfeger.
Sauerman Bros.
Smith Co., T. L. The.

Expansion Joint Compound.
The Barrett Co.
Philip Carey Co., The.
Pioneer Asphalt Co.
Truscon Steel Co.

Explosives.
E. I. du Pont de Nemours & Co.

Fence, Iron.
Cincinnati Iron Fence Co.

Fillers (Paving Joint).
Barber Asphalt Paving Co.
The Barrett Co.
Philip Carey Co., The.
Pioneer Asphalt Co.
Sinclair Refining Co.
The Texas Co.

Fire Brick.
Cannelton Sewer Pipe Co.
Dee Clay Mfg. Co., W. E.

Flue Liners.
Cannelton Sewer Pipe Co.
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Forms, Sidewalks, Curb & Gutter.
Heltzel Steel Form & Iron Co.
Truscon Steel Co.

Forms, Road.
Heltzel Steel Form & Iron Co.
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Forms (Sewers & Conduits).
Heltzel Steel Form & Iron Co.

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Hoists—Motor Truck.
Columbian Steel Tank Co.

Hoists, Steam.
C. H. & E. Mfg. Co.
Lewis-Hall Iron Works.
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F. C. Austin Machinery Co.
Barber Asphalt Paving Co.

Hydrants.
Flower Valve Mfg. Co.

Inlets (Sewer).
Dee Co., Wm. E.
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Insulating Material.
The Barrett Co.
Pioneer Asphalt Co.

Iron Fence.
Cincinnati Iron Fence Co.

Joint Fillers (Paving).
The Barrett Co.
Philip Carey Co., The.

Kettles (Portable).
Barber Asphalt Paving Co.
Cummer & Son Co., The F. D.
Good Roads Machinery Co., Inc.

way, which will be completed this year; also paving of Kings Hwy., 36th to 42nd Sts. Cost of projs. $131,000 and $72,000, respectively.

Minn., Minneapolis — Hennepin Co. Commrs. will establish direct road from here to Forest Lake, 23 miles. H. R. Chase, Chmn. Co. Bd.

Minn., Red Lodge—City Engr. G. C. Pruett, Miles City, preparing plans for short cut from here to Yellowstone Pk. and Cooke City.

Minn., Wabasha—Wabasha Co. plans to gravel 15 miles State Rd., 12.4 ft. wide. Est. cost abt. $75,767. Fed. Aid requested. C. M. Matthies, Wabash, Engr.

Minn., Warren—Marshall Co. considering changing route of Jefferson Hwy., no. of Thf. River Falls, along Gt. Northern and thru Holt, Greenbush, Halma and Bronson.

Miss., Jackson—$1,000,000 bonds voted by Hinds County to construct roads.

Miss., Pittsboro—Sixty-mile hard surface roads in Calhoun Co. will be constructed. E. A. Enoch in charge, Vardaman, Miss. $1,000,000 available. J. B. Causey, Engr., Calhoun City.

Miss., Waynesboro—$75,000 bonds voted by Wayne Co. for constructing gravel roads.

Mont., Helena—W. M. Spann, Dist. Engr., State Hwy. Comn., will soon begin work of locating new route for rd. over main range of Rocky Mtns., to take place of Priest's Pass Rd. Survey is to be made over 3 routes. R. S. Zahniser, Office Engr. Comn.

Neb., Ord—Engrs. Rohrbough Engrg. Co., 929 Natl. Bk. Bldg., Omaha, preparing plans for extensions to paving here. W. E. Walter, City Clk.

Neb., Wilber—Plans under way for grading road betw. here and Western. Geo. E. Johnson, St. Engr., 2769 Garfield, Lincoln. Jos. M. Korbel, Co. Clk. Est. cost $79,706.

N. Y., Albany—City plans paving of nearly 100 streets.

N. D., Burlington—Federal road betw. here and Carpio will be improved. R. W. Kennard, Minot, Aud. Ward Co. Est. cost $100,000.

O., Akron—City contemplates impvt. program, including paving, grading and laying walks, also resurfacing. Total cost $3,000,000. More than 25 miles of streets will be improved. E. A. Kemler, City Hwy. Engr.

O., Pt. Clinton—Council has taken steps to get co-operation of Co. Commrs. and state aid for rebldg. Camp Perry Rd.

O., Springfield—Elston, Axon & Russell, Cons. Engrs., Springfield, have been retained by Camden County Court and State to make survey and plans for state hwy. across Camden Co., from Miller Co. line to Dallas Co. line thru Linn Creek.

Okla., Ada—Council has retained Johnson & Benham, Cons. Engrs., Kansas City, Mo., to design and supervise the constr. of paving work now under contemplation. It is estimated there will be about 15 blks. paving at cost of $150,000.

Okla., Alva—City contemplates paving 15 blocks at estimated cost of $150,000. Johnson & Benham, Cons. Engrs., Kans. City, Mo.

Okla., Duncan—Paving petitions being circulated which, if successful, will mean the paving of about 50 additional blocks.

Okla., Tulsa—Ests. for impvt. of N. Boulder Ave., N. Cheyenne Ave., N. Lewis Ave., and Terrace Drive (20 blks.) will be prepared by City Engr.

Ore., The Dalles—Survey work on scenic loop highway above The Dalles will probably start in near future, if weather conditions permit. Rd., when completed, will lead around the bluffs for 3 miles.

Pa., Hazelton—Council having plans prepared and will receive bids this winter for paving 1,800 ft. Church St.—8th to 17th Sts., cost $24,806; 2,000 ft. Poplar St., $28,176, both cem. base with amiesite coat; 2,000 ft. N. Locust St., cem. base with amiesite top or some other approved bitum. mix., $42,037; all above 40 ft. wide, and various other streets amounting to $100,000. J. Rough, City Engr.

Pa., Phila.—Mayor Moore has asked appropriation to purchase street cleaning equipt. Council considering municipal street cleaning in two districts. Est. cost of equipt., $400,000.

Tex., Comanche—$200,000 bonds voted by Comanche Co. Commrs. to improve roads in De Lean Rd. Dist.

Tex., El Paso—Reeves Co. Precinct No. 2 (Toyah) will call for bids for project covering some 12 to 14 miles, as soon as plans have been approved. Survey of No. 1 from Jeff Davis county line, 32 miles east has been finished. $80,000 now available for work. Jeff Davis County has completed location from Ft. Davis, county east, east thru Limpia Canyon to east county line, and now locating from Kelly ranch some 25 miles west of Ft. Davis to that town. Plans and ests. for 7.2 mi. of Hwy. No. 1 thru Jeff Davis Co. submitted for approval. Hudspeth County has not yet employed an engineer, though their finances have been arranged. El Paso Co. will soon call for bids for grading and bridging 12 miles Hwy. No. 1. Wand County has submitted plans and ests. on 12½ miles Hwy. No. 1 from Pyote to Monahans. D. E. H. Manigault, Div. Engr., 103 Court House, El Paso.

Tex., McKinney—Collin County will construct roads in Copeville and Lavan Districts. $24,000 and $60,000 bonds voted.

Va., Richmond—Plans for widening of Bank Street laid before Governor Davis by Mayor Ainslie. As soon as plans are approved bids will be invited. Blue prints prepared by Director of Pub. Wks. Chas. E. Bolling, call for an addn. of 15 ft. in width of street, erection of conc. retaining wall along front of Capitol Sq., with larger entrances at 9th, 10th, 11th and 12th streets.

Wn., Seattle—Engineer has submitted estimates of cost for paving, grading and conc. walks on Wilson Ave. et al., $101,245; grading, necessary walks and conc. curbs on Walcott Ave., et al., $13,918.

Wash., Seattle—Total of $6,000,000 apportioned by Bureau Pub. Rds. for federal hwy. constr. in Idaho, Montana, Oregon and Washington for fiscal year ending July 1, 1921. States or communities in which fed. funds are used must expend equal sum, which means total of over $12,000,000 for rd. bldg. in Northwest, in addition to other state and county highway work.

Wis., Ashland—State Hwy. Commr. A. R. Hurst, Madison, has ordered hard-sur-

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The Gramm-Bernstein Motor Truck Co.
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Lewis-Hall Iron Works.
Packard Motor Car Co.
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Municipal Castings.
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Madison Foundry

Packing.
Pioneer Asphalt Co.

Paints (Asphalt).
Barber Asphalt Paving Co.
Barrett Co., The
Pioneer Asphalt Co.

Paving Blocks (Creosoted).
The Barrett Co.
Republic Creosoting Co.

Paving Brick.
Medal Paving Brick Co.
Metropolitan Paving Brick Co.
Murphysboro Paving Brick Co.
National Paving Brick Mfrs. Assn.
Springfield Paving Brick Co.

Paving Contractors.
Warren Bros. Co.

Paving Joint Compound.
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The Barrett Co.
Philip Carey Co., The.
Pioneer Asphalt Co.

Paving Joint Filler.
Barber Asphalt Paving Co.
The Barrett Co.
Pioneer Asphalt Co.

Paving Machines.
Austin Machinery Corporation.
Cummer & Son Co., The F. D.
East Iron & Machine Co., The
Warren Bros. Co.

Paving Plants (Asphalt).
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Barber Asphalt Paving Co.
Cummer & Son Co., The F. D.
East Iron & Machine Co.
Good Roads Machinery Co., Inc.
Smith Co., T. L. The.
Warren Bros. Co.

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Pioneer Asphalt Co.
The Texas Co.

Pipe Manufacturers.
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U. S. Cast Iron Pipe & Fdy. Co.

Pitch Filler.
The Barrett Co.
Warren Bros. Co.

Plows (Rooter and Wing).
Austin-Western Road Cach. Co.

Portable Paving Plants.
Austin Machinery Corporation.
Cummer & Son Co., The F. D.
East Iron & Machine Co., The
Good Roads Machinery Co., Inc.
Warren Bros. C o.

Portable Stone Bins.
Austin-Western Road Machinery Co.
Good Roads Machinery Co., Inc.

Pumps.
C. H. & E. Mfg. Co.
De Laval Steam Turbine Co.
Harris Air Pump Company.
Smith Co., T. L., The.

Reinforcing For Pavements.
American Steel and Wire Co.
Truscon Steel Co.

Road Building Material.
Barber Asphalt Paving Co.
Kentucky Rock Asphalt Co.
Sinclair Refining Company.
The Texas Co.

Road Binder.
Barber Asphalt Paving Co.
The Barrett Co.
Pioneer Asphalt Co.
Sinclair Refining Company.
Standard Oil Co. (Indiana)
The Texas Co.
Uvalde Asphalt Paving Co.
Warren Bros. Co.

Road Forms.
Heltzel Steel Form & Iron Co.
Truscon Steel Co.

Road Graders.
Austin-Western Road Machinery Co., The
Good Roads Machinery Co., Inc.

Road Machinery.
Austin Machinery Corporation.
Austin-Western Road Machinery Co., The
Barber Asphalt Paving Co.
Cummer & Son Co., The F. D.
East Iron & Machine Co., The
Good Roads Machinery Co., Inc.
Mayer, F.
Warren Bros. Co.

Road Planer.
Austin-Western Road Machinery Co.

Road Oils and Preservatives.
Barber Asphalt Paving Co.
The Barrett Co.
New Orleans Refining Co.
Standard Oil Co. (Indiana)
The Texas Co.

Road Rollers.
Austin-Western Road Machinery Co., The
Barber Asphalt Paving Co.
Good Roads Machinery Co., Inc.

Rock Crushers.
Austin-Western Road Machinery Co., The
Good Roads Machinery Co., Inc.

Rock and Sand Heaters.
East Iron & Machine Co., The

Roofing Material.
Barber Asphalt Paving Co.
The Barrett Co.
Philip Carey Co., The.
Pioneer Asphalt Co.
The Texas Co.
Warren Bros.

Sand Dryers.
Cummer & Son Co., The F. D.

Saw Rigs.
C. H. & E. Mfg. Co.

Sandstone.
Cleveland Stone Co.

Scarifiers.
Austin-Western Road Machinery Co., The
Good Roads Machinery Co., Inc.

Scrapers, Drag Line.
Pawling and Harnischfeger.
Sauerman Bros.

Scrapers, Graders, Plows, Etc.
Austin-Western Road Machinery Co.
Good Roads Machinery Co., Inc.

Scrapers, Power.
Sauerman Bros.

Sewage Treatment.
Direct Oxidation Process Corp.
Electrolytic Sanitation Co.

Sewer Braces.
Kalamazoo Fdry. & Mach. Co.

Sewer Castings.
Dee Co., Wm. E.
Madison Foundry Co.

Sewer Cleaning Machinery.
Stewart, W. H.

Sewer Forms.
Heltzel Steel Form & Iron Co.

Sewer Pipe.
Cannelton Sewer Pipe Co.
Dee Clay Mfg. Co., W. E.
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Sewer Rods.
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Sluice Gates.
Coldwell-Wilcox Co.

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Truscon Steel Co.

Steel Tapes.
Kolesch & Co.
Lufkin Rule Co., The

Stone Crushers.
Austin-Western Road Machinery Co.

Stone Curbing.
Cleveland Stone Co.

Stone Elevators.
Austin-Western Road Machinery Co.

Stone Flagging.
Cleveland Stone Co.

Stone Spreaders.
Austin-Western Road Machinery Co.
Burch Plow Works Co.

Stone Screens.
Austin-Western Road Machinery Co.
Good Roads Machinery Co., Inc.

Street Cleaning Machinery (Horse Drawn).
Austin-Western Road Machinery Co., The

Street Crossings.
Cleveland Stone Co.

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Austin-Western Road Machinery Co.

Street Paving Material.
Barber Asphalt Paving Co.
The Texas Co.

Street Sprinklers (Horse Drawn).
Austin-Western Co., Ltd., The

Structural Steel.
Lewis-Hall Iron Works.

Surveyors' Instruments.
Kolesch & Co.
Lufkin Rule Co., The

Sweepers.
Austin Machinery Corporation.
Austin-Western Road Machinery Co., The
Elgin Sales Corp.

Tamping Machines.
Pawling and Harnischfeger.

Tanks, Water Supply.
Mensch, L. J.

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The Barrett Co.
Philip Carey Co., The.

Tar Heaters.
Littleford Bros.

Tarvia.
The Barrett Co.

Testing Chemists.
Dow & Smith
Walter H. Flood
Howard, J. W.
Kirschbraun, Lester
Van Trump, Isaac.

Traction Engines.
Austin-Western Road Machinery Co., The

Traction Engines (Oil or Kerosene).
Austin-Western Road Mach. Co.

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Austin Machinery Corporation.

Trench Braces.
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Trench Machinery.
Austin Machinery Corporation.
Kalamazoo Fdy. & Machine Co.
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De Laval Steam Turbine Co.

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STATEMENT OF THE OWNERSHIP, MANAGEMENT, CIRCULATION, ETC., REQUIRED BY THE ACT OF CONGRESS OF AUGUST 24, 1912.

OF MUNICIPAL AND COUNTY ENGINEERING published monthly at Indianapolis, Indiana, for October 1, 1920.

State of Indiana, County of Marion, ss.:

Before me, a Notary Public in and for the State and County aforesaid, personally appeared John H. Pritchard, who, having been duly sworn according to law, deposes and says that he is the Business Manager of MUNICIPAL AND COUNTY ENGINEERING, and that the following is, to the best of his knowledge and belief, a true statement of the ownership, management (and if a daily paper, the circulation), etc., of the aforesaid publication for the date shown in the above caption, required by the Act of August 24, 1912, embodied in section 443, Postal Laws and Regulations, printed on the reverse of this form, to-wit:

1. That the names and addresses of the publishers, editor, managing editor, and business manager are:

Publisher, Engineering Publishing Company, Inc., 702 Wulsin Bldg., Indianapolis, Indiana.

Editor, Samuel C. Hadden, 538 South Clark Street, Chicago, Illinois.

Managing Editor, Samuel C. Hadden, 538 South Clark Street, Chicago, Illinois.

Business Manager, John H. Pritchard, 702 Wulsin Building, Indianapolis, Indiana.

2. That the owners are:

Engineering Publishing Company, Inc., 702 Wulsin Building, Indianapolis, Indiana.

Alexander P. Fox, 704 Wulsin Building, Indianapolis, Indiana.

George O. Wildhack, 927 North Meridian Street, Indianapolis, Indiana.

John H. Pritchard, 702 Wulsin Building, Indianapolis, Indiana.

Edgar J. Buttenheim, Tribune Building, New York City, N. Y.

3. That the known bondholders, mortgagees, and other security holders owning or holding 1 per cent. or more of total amount of bonds, mortgages, or other securities are:

Alexander P. Fox, 704 Wulsin Bldg., Indianapolis, Indiana.

4. That the two paragraphs next above, giving names of the owners, stockholders, and security holders, if any, contain not only the list of stockholders and security holders as they appear upon the books of the company, but also, in cases where the stockholder or security holder appears upon the books of the company as trustee or in any other fiduciary relation, the name of the person or corporation for whom such trustee is acting, is given; also that the said two paragraphs contain statements embracing affiant's full knowledge and belief as to the circumstances and conditions under which stockholders and security holders who do not appear upon the books of the company as trustees, hold stock and securities in a capacity other than that of a bona fide owner; and this affiant has no reason to believe that any other person, association, or corporation has any interest direct or indirect in the said stocks, bonds, or other securities than as so stated by him.

JOHN H. PRITCHARD,
Business Manager.

Sworn to and subscribed before me this 4th day of October, 1920.

(Seal) H. A. RONEY.

(My commission expires March 16, 1923.)

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faced roads betw. here and Iron River, following Northern Pacific route, 33 miles.

Wis., Racine—Co. State Rd. and Bridge Comn., Racine Co., recommend completion of 12th Street Rd., from Racine to Rochester; Rochester to Burlington, Burlington to Geneva Rd. to Walroth Co. line. Hwy. Commr. Wm. O. Thomas, Racine, also instructed to make survey of following roads. Durand Rd.—Racine to Corliss; No. Cape Rd., 12th St. to Milwaukee Co. line; Rochester-Waterford-Windlake Rd.—12th St. in Rochester thru Waterford to Sec. 24; Burlington-Elkhorn Rd., S T H 20, from Burlington to Walworth county line.

SEWERAGE AND SEWAGE TREATMENT.

Ariz., Chandler—Council considering construction of sewer system. Survey made by Engrs. Hancock and Bradstreet and Engr. Hancock has agreed to take charge of work on a per diem basis plus 5%. About 8 miles of pipe would be required.

Ark., Bentonville—W. L. Winters, Engr., Ft. Smith, Ark., preparing prelim. plans for sewer district recently organized.

Ark., Parkin—Newsome Engrg. Co., neers for work in proposed sewer district.

Cal., Los Angeles—Ords. adopted to construct cement pipe sewer in Harvard Blvd. betw. Temple St. and Oakwood Ave.; also vitr. pipe sewer in Sycamore Park Dr. betw. eastern term. and Pasadena Ave.; also cement pipe sewer in Ravenna Ave.—J to K Sts.; cement pipe sewer in Farmer St.—Emerald to 1st alley west and vit. pipe sewer in Amethyst.

Cal., Selma—$90,000 bonds voted here for new outfall sewer. An 18-in. sewer will be laid parallel to present 12-in. sewer.

Cal., Watts—Resolution adopted to construct sewer system, disposal plants, etc., at estimated cost of $120,000. Koebig & Koebig, Cons. Engrs., Los Angeles. Bond issue will be submitted at Nov. election.

Ont., Welland—City Council has decided to engage consulting engineer to take up question with city engineer of sewerage plans for Parkway Heights.

Ill., W. Frankfort—Bd. Local Impvts. retained C. B. Mautz, Engr. Benton, to prepare plans for storm sewers in N. Douglas St., involving about 4,000 ft. 36-in. pipe.

Ill., Wauconda—Board Local Impvts. contemplates constructing 11,548 ft. 8-in. concrete tile and 943 ft. 10-in. conc. tile sewer. Abt. 12,000 ft. 6-in. and 8-in. cast iron water mains. Ord. being prepared. Est. cost of sewer $30,022; water, $33,000 approx. J. L. Pickens, Engr., Kankakee, Ill.

Ia., Stanhope—Owners ready for bids soon for san. sewer system. M. N. Mitchell, City Clk. Plans under way. Est. cost $40,000.

Kans., Stockton—Plans being prepared for bldg. 60,000 ft. san. sewers in various streets. E. Taichu Co., New Eng. Bldg., Kans. City, Mo., Engrs.

Minn., Duluth—Residents have petitioned City Council for sanitary sewer in Huntington Street—16th alley west to 61st alley.

Mo., Joplin—City contemplates constructing san. sewers: $291,000. 111,229 ft. 8 to 30-in. pipe; 287 manholes; 57,000 cu. yds. earth excav.; 430 cu. yds. concrete. S. B. Ashcraft, City Engr.

Mo., Springfield—Plans being prepared for bldg. sewers in District No. 9, involving 24,000 ft. 8-in. vitr. pipe. Abt. $40,000. W. C. Fuller, Springfield, Engr.

Neb., Chappell—Plans being prepared by Henningson Engrg. Co., Engrs., National Bldg., 12th and Harney Sts., Omaha, for sewerage system. About $80,000.

Neb., Ord—Final plans under way for 3 miles comb. sewer extension. Rohrbaugh Engrg. Co., 929 City Nat. Bank Bldg., Omaha, Cons. Engrs. W. E. Waters, City Clk.

Pa., Coaldale—Citizens are petitioning Co. Commrs. to hold special election to vote on question of borrowing $75,000; funds to be used for bldg. sewers and street impvts.

R. I., Lonsdale (Pawtucket P. O.)—Lonsdale Company considering constr. of sewerage system for its plant and houses. Engineer not yet selected.

S. D., Madison—$50,000 bond issue authorized by citizens for sewer construction and extension.

Wis., New London—Plans being drawn for san. sewer system. C. J. Thompson, City Clk.; H. R. Oberst, Engr.

Wis., West Allis—City Engr. instructed to prepare plans for storm sewers in Fourth Ward. Board Pub. Wks. will call for bids for cleaning septic tank.

WATER SUPPLY AND PURIFICATION.

Ariz., Tombstone—Engr. W. H. Elliott, who has been retained by San Pedro Water Users' Assn., to take charge of Charleston dam proj., will make Tombstone his headquarters for next 4 mos. while prelim. surveys and drilling for dam site are in progress.

Ark., Atkins—Ford & MacCrea, Little Rock, Engrs., preparing prelim. plans for water wks. and sewer extensions; 2 districts. $60,000 available for each district. Dr. Adelyne, Dr. Griffin and C. Bell, Commrs. for both districts.

Cal., Los Angeles—Sespe Light & Power Co., Merchants Tr. Bldg., authorized by State Railroad Commission to issue $1,000,000 stock and $2,000,000 bonds to finance hydro-electric proj. on Sespe River in Ventura Co. Company proposes to construct 5 power plants.

Ont., London—City contemplates development of sulphur well and establishment of $20,000 plant to purge sulphur from water in the hope that this will provide city with an adequate supply of spring water.

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Ont., Can., London—Utilities Comm. will replace all 4-in. water mains with 8 or 10-inch mains.

Ont., Newmarket—By-law to devote $20,000 for additional equipt. for water works here has been passed.

N. B., St. Andrews—Plans being prepared for extension to water works. Est. cost $100,000. E. S. Polleys, Clk.

Ont., St. Thomas—Water tower in Amelia St. is to be placed in efficient working order immediately. Mr. Lea, Montreal, Expert Hydr. Engr., will investigate cost of doubling water supply for city.

Ont., Windsor—Water Commission decided to install water meters where water consumption is heavy.

Ill., Wauconda—Village contemplates following work; 12,000 ft. 6 and 8-inch cast iron water mains; 11,548 ft. 8-in. conc. tile and 943 ft. 10-in. conc. tile sewers. Ords. being prepared. Work passed at public hearing. Est. cost water mains, $33,000 approx.; sewers, $30,022. City Engr. J. L. Pickens, Kankakee, Ill.

Kans., Osawatomie—Plans being prepared by Black & Veatch, Engrs., Mutual Bldg., Kans. City, Mo., for addition to water power plant; brick, rein. conc. flooring, rein. conc. dam, etc., to impound 60,000,000 gals. $85,000 bonds voted for project.

Kans., Ottawa—City will extend and improve water and light plant, with addn. of a filtr. system. $165,000 bonds.

Mass., Fall River—City having plans prepared by H. K. Barrows, Archt. & Engr., 6 Beacon St., Boston, for 1 sty. 35x40 ft. brk. and steel pumping station; also rein. conc. dam across Watuppa Pond. About $150,000. J. H. Kay, Mayor.

Miss., Oxford—$30,100 bonds voted by city for repair, remodeling and improving water works and light plant.

Neb., Chadron—$89,595 bonds carried at election for water works construction. G. E. Marriott, City Clk.

Neb., Paxton—$60,000 bonds voted to construct municipal water and light system.

Neb., Shelton—Water test from test well, recently bored at city pumping plant, shows water unsafe. F. A. Kimbrough, Shelton.

Neb., Sidney—Plans being prepared by R. D. Salisbury, Engr., 1415 E. Colfax Ave., Denver, Colo., for water works system. Abt. $126,000.

Neb., Tecumseh—City considering installing filtr. plant at Nemaha River draing. canal for city water supply. Present supply from wells insufficient.

N. J., Clifton—Council passed resolutions authorizing engineer to prepare plans for water distributing system for Delawanna and Albion Pl. Delawanna system est. at $98,015, and Albion Place, $135,000.

N. C., Cherryville—Town has issued $90,000 bonds. Will install water system. W. C. Hicks, Clk.

O., Delaware—M. Knowles, Engr., Hippodrome Bldg., Cleveland retained to prepare plans for water works system to include two wells. G. Irwin Direct. Pub. Serv.

O. Hamilton—Council passed ord. calling for issuance of $150,000 bonds for impvt. of water works extension and repair of present water works.

Okla., Strong City—City plans constr. of water works; $40,000. H. G. Olmstead & Co., Engrs., 415 Oil Exch. Bldg., Okla. City.

Ore., The Dalles—City considering following: Dam across Mill Crk., piping and filtering water from Columbia and bringing water from the Deschutes River.

Pa., Phila.—Establishment of storage reservoirs along watersheds of Perkiomen and Tohickon creeks, north of city, recommended as part of future water supply of municipality in report submitted to Mayor by Comn. of engineers who has worked out plans to cover a supply for next fifty years.

S. D., Flandreau—City will sink new wells for water supply in Russell pasture. Tests from old wells show water to be unsafe. Alton Lockee, Supt. Water Dept.

S. D., Madison—$50,000 bond issue authorized by citizens, to be used for extension of water works.

Tex., Amarillo—City contemplates improving water and electric light plants. $200,000.

Tex., Ennis—City will purchase machine for purification of lake water by liquid chlorine.

Tex., Moran—Albany Light & Stone Quarry Co., Albany, considering constr. of high-power electrical transmission line from Albany; installing water works; dam Deep Creek for water reserve, etc., at $90,000.

Tex., Paris—$1,000,000 bonds voted here to construct reservoir to hold 4 billion gals. water and to make modern entire water works.

Tex., Port Arthur—Supvrs. Port Arthur Fresh Water Dist. contemplate conveying water from Sabine River, 10 miles above Orange near Kans. City Southern R. R. crossing; install 2 pumping plants, settling basin and cement aqueduct from Port Neches. Est. cost $1,800,9000. Nagle-Witt-Rollins Engrg. Co., Engrs., Dallas, Tex.

Tex., Wichita Falls—$4,500,000 bonds voted for comb. water supply and irrigation system at Wichita County. Diversion dam will be built several miles above Wichita Falls and another dam thru city of Wichita Falls.

Va., Norfolk—City contemplates improving water works; repairing bldg., installing pumps and high-pressure boilers, at $250,000. Chas. E. Ashburner, Mgr.

Wn., Aberdeen—City may adopt new Ord., prepared by Water Supt. Geo. Bowen, along similar lines to Ord. now in force in Seattle. It prepares the way for placing entire city eventually under meter system. Meters are to be installed as fast as can be secured; for the business section first, including mill district. There are approx. 3,300 water taps in city and only 430 meters.

Wn., Centralia—Impvts. estimated to cost $47,000, contemplated by town of Bucoda for immediate future. C. P. Hicks engaged as engineer for town. Work includes system of walks, water system and sewer system. Est. cost of water system, $20,000; sewers, $8,000.

W. Va., Wheeling—Indiana Air Pump Co. granted one week by Council before closing presentation of propositions for providing City with pure water. Company's plans ready but as question is still under discussion by State Dept. of Health, Company is unable to present plans. Can provide city with water in sufficient quantity and best quality at sum not to exceed $800,000.

Wyo., Evanston—$290,000 bonds voted to construct water works system. W. Cook, Clk.

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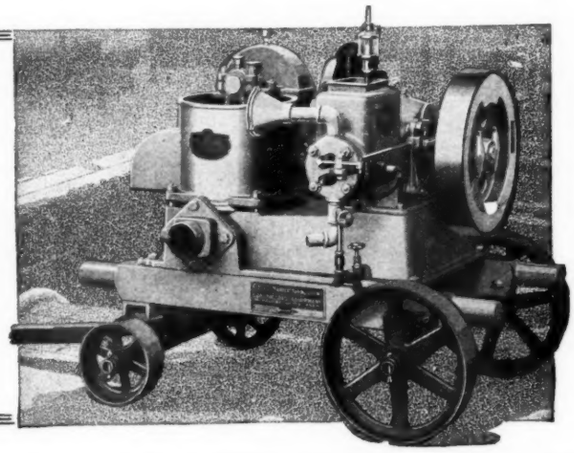

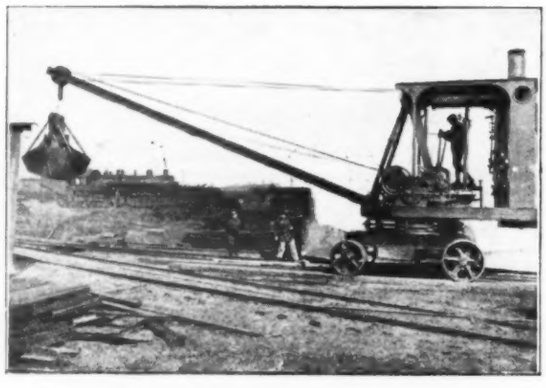

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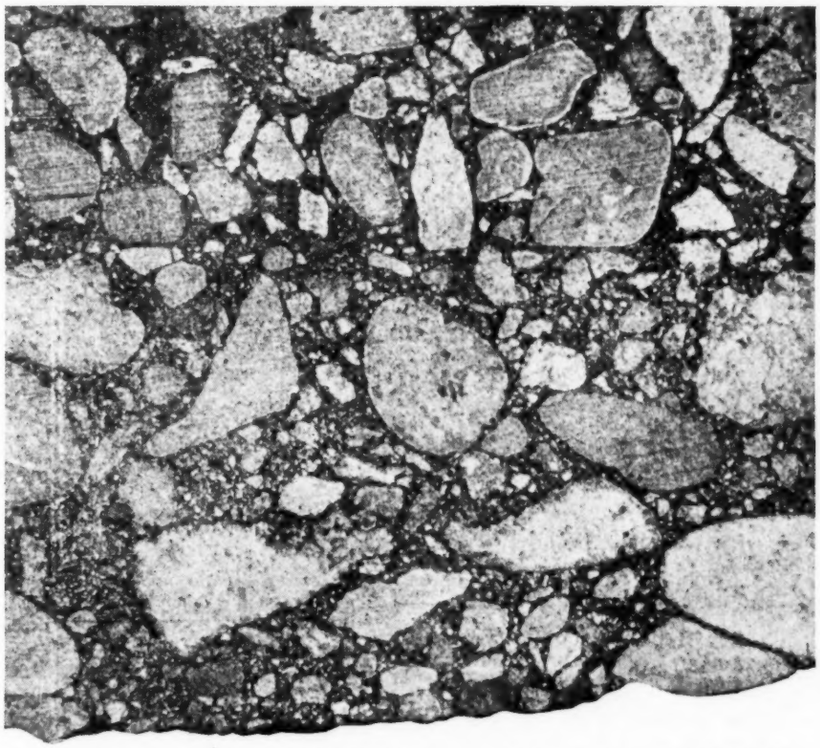

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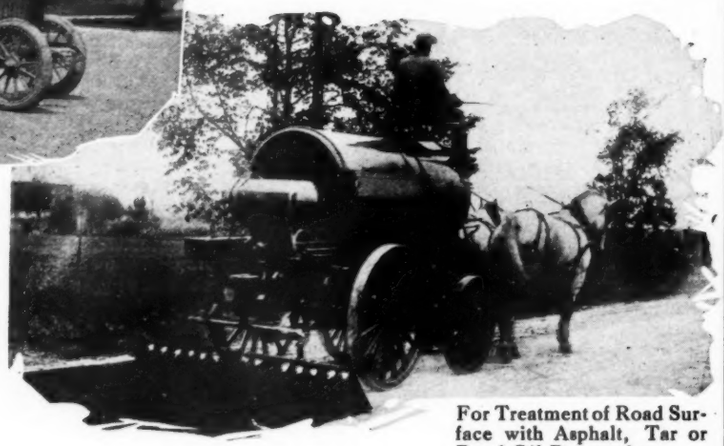

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